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Breeding Pattern of the Eastern Spadefoot Toad

By KEITH L. HANSEN

The reproductive behavior of the eastern spadefoot toad, *Scaphiopus h. holbrooki* (Harlan), presents one of the most unusual cases of anuran breeding in eastern North America. Herpetologists recognize that this species, throughout its range, breeds during the warmer months of the year following periods of heavy rain.

From the literature and through personal communication, records are available of 145 breeding choruses observed by 44 herpetologists and naturalists. Table 1 gives these breeding records arranged geographically. A number of significant factors concerning breeding were revealed.

1. Herpetologists generally agree that breeding is associated with, or initiated by, heavy rain. The average rain for 43 choruses was 2.74± 0.22 in., ranging from a low of 0.39 to a maximum of 8.0.

2. Relatively warm air and water are necessary for breeding since low temperatures are known to inhibit it. Temperatures are in Fahrenheit throughout this paper. Bragg (1945) stated that breeding by *S. bombifrons* usually occurs above 52°, although males may call at about 45°. Ball (1936) reported that *S. h. holbrooki* bred in Connecticut in 1933 and 1934 when the air temperature had risen to 46° and 49°, respectively. In Jan., 1955, the weather station at Gainesville, Fla. reported precipitation and minimum-maximum temperatures: Jan. 22nd: 0.33 in., 47-62°; 23rd: 1.97 in., 45-48°; and 24th: 0.45 in., 38-41°. Sufficient rain had fallen by the night of Jan. 23 to form numerous temporary ponds in areas inhabited by spadefoot populations. However, no breeding occurred on any of the three nights. Temperature was almost certainly the limiting factor since these populations bred on February 7 after considerably less rainfall (0.61 inches) than two weeks previous. The temperature had risen, however, to a minimum-maximum of 50°-75°. March 28 and 29, a total of 1.28 inches fell, with minimum temperatures of 37° and 33°, respectively. Again, temperature seemed to be the limiting factor as no breeding occurred. Summarizing these field records, it appears that the lower limiting temperature for spadefoot breeding lies between 45° and 50°.

Of the 36 minimum-maximum temperature records reported on breeding dates, the mean minimum was 66.2 ± 1.47°, the mean maximum, 80.1 ± 1.73°. The mean temperature for 40 choruses was 72.1 ± 1.36°.

3. Spadefoot toads breed almost exclusively in temporary water, such as collects in roadside ditches, drainage basins and low fields. From 98 references mentioning the types of breeding pools, only one, Overton (1914), mentioned the use of a small permanent pond following heavy rains. Recently, two reports of breeding in front-yard fish pools have been made by Twente and also Hansen (unpubl. data).

4. Records reveal that a single population may breed several times a year in the necessary environmental conditions. Single populations have been reported eight different times to breed twice in one year. Triple breedings on four occasions and one of four breedings in one year have been reported. C. J. Goin and N. D. Richmond (unpubl. data) report five breedings in one year. The problem arises as to whether the same individuals breed several times within a year, or whether different members of the population breed at different times. The latter is probably the case, because on two occasions I have witnessed breeding by a few dozen members of a population, while scores of individuals within several hundred feet made no visible attempt to join the chorus.

5. Optimum temperature and heavy rain are necessary to breeding because known populations have gone extended periods without breeding when these conditions do not prevail. Richmond (1947) reported a chorus on August 5, 1950, and mentioned that this population had not laid in the previous year. In correspondence, Richmond stated that the same population failed to breed during 1942, 1952 and 1954. Mrs. O. B. Goin wrote on March 14, 1957, that no breeding chorus had been recorded in her vicinity near Gainesville, Fla., since August 23, 1953, although breeding might possibly have occurred during her absence in the summer of 1955. During the exceptionally dry 1954, no breeding occurred in a large population near Gainesville, Fla.

6. It is generally accepted that the eastern spadefoot is exclusively nocturnal so it might be expected that this species breeds only at night. Bragg (1945) mentioned that he had found no case of *holbrooki* breeding in daylight. From 73 cases in which the time of breeding was reported, 27 choruses occurred at least partially in the day. Sixteen choruses were listed as taking place during both night and day, eleven choruses occurred exclusively during the day. In general, daytime breeding is probably accompanied by overcast, cloudy skies and rainfall. However, Wright (1932) stated that one breeding occurred in full daylight.

7. A number of herpetologists have assigned a given number of months as the breeding season. Sherwood (1897)-Apr. to June; Ball (1936)—Apr. through Aug. in Conn.; Driver (1936)—Apr. 1 to Aug. 31; Carr (1940)—mid-summer to mid-Oct. in Fla.; Wright and Wright (1949)—Mar. to Sept.; Neill (1957)—Mar. until cool weather of fall. Actually the spadefoot breeds in every month except Nov. The preponderance of breeding occurs in the spring (67 choruses) and in the summer (52 choruses). Breeding in the fall (16 choruses) is reduced and only ten choruses are known from the winter months.

8. The eastern spadefoot ranges from Mass. to Fla. and from southeastern Ill. to eastern Tex. When breeding dates are considered geographically, some striking differences are noted. Fig. 1 shows the breeding records, by months, from the northern, central, and southern portions of the range.

Table 1. Breeding records of *Scaphiopus h. holbrooki* by geographical distribution

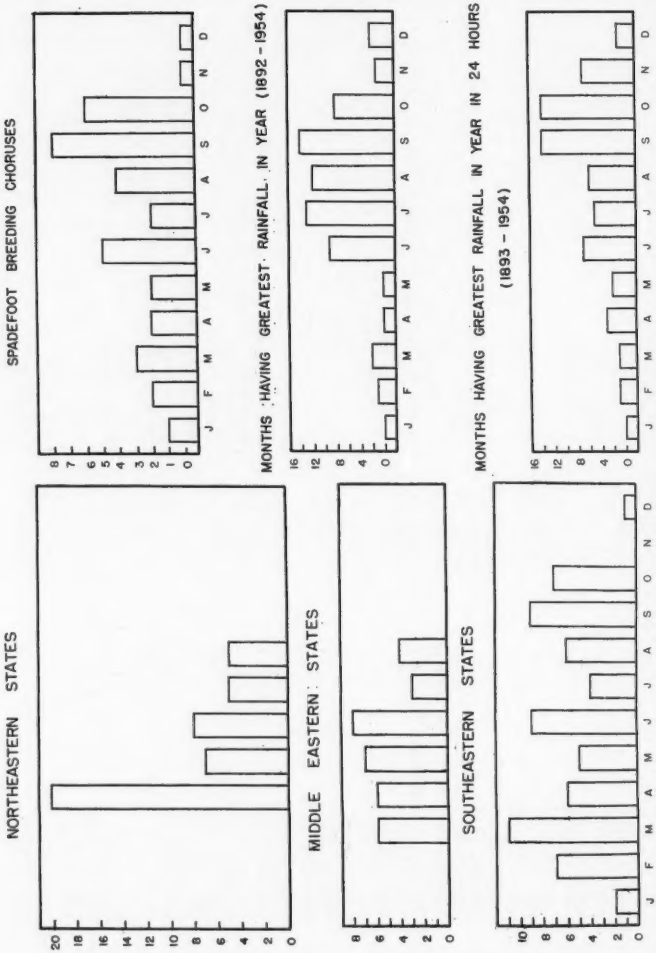
Locality of Breeding Site	Date of Breeding Chorus	Inches of Rainfall	Air Temp. °F	Naturalist	Source
NORTHEASTERN STATES					
Springfield, Mass.	June, 1863	-	-	Allen, J. A.	Proc. Boston Soc. Nat. Hist. 12:171-204.
Cambridge, Mass.	May 27-28, 1866	-	-		
	April 1, 1868	-	-		
	April 15, 1868	-	-		
	May 14, 1868	-	-		
	May 22, 1868	-	-		
Danvers, Mass.	Aug. 12, 1834	-	-	Ball, S. C.	Trans. Conn. Acad. of Arts & Sc. 32:351-79.
	June 16, 1842	-	-		
Boston, Mass.	April 19, 1863	-	-		
	April 29, 1863	-	-		
Northampton, Mass.	April 18, 1933	-	-	Driver, E. C.	Copeia 1936(1):67-69.
	April 17, 1934	-	-		
	April 24, 1934	-	-		
Northampton, Mass.	May 3, 1928	-	-	Dunn, E. R.	Bull. Boston Soc. Nat. Hist. 57:5-8.
Martha's Vineyard, Mass.	Aug. 10, 1887	-	-	Hargitt, C. W.	Am. Nat. 22(258):535-37.
Essex Co., Mass.	July 1825	3.14	-	Nichols, A.	Jour. Essex County Nat. Hist. Soc. 1(3):113-17.
	Aug. 12, 1834	-	-		
	June 16, 1842	-	-		
Cambridge, Mass.	April 19, 1863	-	-	Putnam, F. W.	Proc. Boston Soc. Nat. Hist. 2:229-30.
	April 29, 1863	-	-		
Framingham, Mass.	June 16, 1842	-	-	Wright, A. H.	Life histories of frogs of Okefinokee Samp.
Ansonia, Conn.	April 15-18, 1933	1.66	42-54	Ball, S. C.	Trans. Conn. Acad. of Arts & Sc. 32:351-79.
	June 11, 1933	-	-		
	April 16-17, 1934	1.91	45-50		
	May 2-3, 1934	-	-		
	June 19, 1934	-	-		
	June 18, 1935	-	-		

Westville, Conn.	April 22, 1933	-	-		
Mt. Carmel, Conn.	April 19, 1934	-	-		
New Haven, Conn.	April 29, 1879	-	-	Smith, F. S.	Am. Nat. 13(10)651-52.
Long Island, N. Y.	July 1884	-	-	Ball, S. C.	Trans. Conn. Acad. of Arts & Sci. 32:351-79.
Jamaica, L.I., N.Y.	July 17, 1885	-	-		
Long Island, N.Y.	June 17, 1916	-	-	Nichols, J. T.	Copeia 1917(45):59-60.
	July 23, 1916	-	-		
Patchoque, L.I., N.Y.	April 1912	-	-	Overton, F.	Mus. Brooklyn Inst. Arts. Sc., Science Bull. 2(3):28-30.
	April 27, 1912	-	-		
	April 12-13, 1913	-	-		
	April 27-28, 1914	-	-		
	May 5-6, 1914	-	-		
	July 7, 1914	-	-		
Patchoque, L.I., N.Y.	May 22, 1915	-	-	Overton, F.	Copeia 1915(20):17.
Patchoque, Yaphank, Middle Island, Coram, L.I., N.Y.	Aug. 4-5, 1915	-	-	Overton, F.	Copeia 1915(24):52-53.
Long Island, N.Y.	Aug. 8, 1884	-	-	Pike, N.	Bull. Am. Mus. Nat. Hist. 1(7):213-21.
Albany, N.Y.	April 1940	-	-	Smith, R. H.	Copeia 1952(1):48.
	April 9, 1951	-	-		
		MIDDLE EASTERN STATES			
Montandon, Penn.	May 26, 1943	-	-	Richmond, N. D.	Unpubl. data
Trenton, N.J.	May 1874	-	-	Abbott, C. C.	Am. Nat. 18(11):1075-80.
	April 10, 1884	-	-		
	April 27-28, 1884	-	-		
	June 25-26, 1884	-	-		
Lakehurst, N.J.	Aug. 1-2, 1906	-	-	Davis, W. T.	Proc. Staten Is. Assoc. Arts Sc. 2(2):48-49.
Massey, Maryland	April 1, 1952	-	65	Simmons, R. S.	Unpubl. data.
Benfield, Md.	Aug. 12, 1955	8.0	-	Stine, C. J. Simmons, R. S. Fowler, J. A.	Herp. 12(4):295-96.

New Kent Co., Va.	Aug. 15, 1940	-	77-84	Richmond, N. D.	Ecology 28:53-67.
	Mar. 15, 1944	-	-		
New Kent Co., Va.	May 26, 1938	-	-	Richmond, N. D.	Unpubl. data.
	Aug. 15-16, 1940	-	-		
	July 1941	-	-		
	Mar. 26-27, 1943	-	-		
	Mar. 12, 15-17, 1944	-	-		
	Mar. 23-24, 27-28, 1944	-	-		
	April 23-24, 1944	-	-		
	May 27, 1945	-	-		
	June 19, 1945	-	-		
	July 18, 1945	-	-		
	July 2, 1946	-	-		
	May 26, 29, 1948	-	-		
Radford, Va.	Mar. 26, 1935	-	-		
Ceredo, W. Va.	June 27, 1940	-	-		
Huntington, W. Va.	April 16, 1939	1.67	-	Green, N. B. and	Copeia 1940(2):127.
Wayne Co., W. Va.	April 17, 1939	-	-	Richmond, N. D.	
Lawrence Co., Ohio	June 2, 1946	1.85	-	Green, N. B.	Copeia 1948(1):65
	June 8, 1947	2.58	-		
Athens Co., Ohio	June 1, 1950	-	-	Spangler, P. J.	Ohio Jour. Sci. 50(6):277.
	June 16, 1950	-	-		
Shoals, Indiana	May 3, 1937	-	-	Swanson, P. L.	Am. Midl. Nat. 20(3):713.
Horse Cave, Ky.	June 3, 1935	-	68	Giovannoli	Copeia 1936(1):69.
North Carolina	March 20, 1933	-	60-82	Brandt, B. B.	Copeia 1936(4):215-16.
Raleigh, N. C.	May, 1895	3.46	-	Brimley, C. S.	Am. Nat. 30:500-01.
		SOUTHEASTERN STATES			
AEC Area, Aiken, S. C.	May 4, 1952	-	-	Martof, B.	Unpubl. data.
	Mar. 31, 1954	-	-		
Horry Co., S. C.	July 11, 1945	-	-	Obrecht, C. B.	Copeia 1946(2):71-74.
Dorchester Co., S. C.	March 11, 1953	1.59	-	Quinby, J. A.	Herp. 10(1):8.
Dorchester Co., S. C.	April 7, 1954	-	-	Schwartz, A.	Unpubl. data.

Kershaw Co., S. C.	June 20, 1952	-	-		
Charleston Co., S. C.	Sept. 16, 1932	-	-		
	Feb. 26, 1939	3.5	66		
	Feb. 11, 1940	-	-		
	Aug. 12, 1940	-	-		
	Aug. 20, 1949	-	-		
	July 8, 1950	-	-		
	Feb. 7, 1953	-	-		
Cochran, Ga.	Jan. 6-9, 1953	-	-	Brandt, B. B.	Herp. 9(3):141-45.
Bleckly Co., Ga.	Feb. 14-17, 1953	-	-		
	Mar. 25, 1953	-	-		
	Apr. 1-2, 5-6, 9-10, 1953	-	-		
Blitchtown, Ga.	March 16, 1946	-	-	Lab. of Ornithology	Recording: "Voices of the Night." Cornell U.
Baker Co., Ga.	April, 1948	-	-	Crenshaw, J. W.	Unpubl. data.
Ludowici, Ga.	Oct. 2, 1951	-	-	Martof, B.	Unpubl. data.
Valona, Ga.	Dec. 21, 1951	-	-		
Osierfield, Ga.	April 3, 1952	-	-		
Sapelo Is., Ga.	June 23, 1955	-	-		
	June 28, 1955	-	-		
Statesboro, Ga.	March, 1953	-	-	Simmons, R. S.	Unpubl. data.
Chesser Is., Ga.	June 14, 1922	-	-	Wright, A. H.	Life histories of frogs of of Okefinokee Swamp.
Miami, Fla.	Oct. 8, 1952	3.45	73	Bell, L. N.	Unpubl. data.
	Oct. 27, 1952	6.94	74-76		
	Sept. 18-19, 1953	1.66	70-87		
Miami Beach, Fla.	June 27, 1953	1.39	73-84		
Homestead, Fla.	June 25, 1954	0.56	69-90		
Tarpon Springs, Fla.	Sept. 1-3, 1953	1.67	74-83	Carr, A. F.	Univ. of Fla. Biol. Sc. Series 3(1):1-116.
Miami, Fla.	May 16, 1920	3.14	69-76	Deckert, R. T.	Copeia 1921(91):20-23.
Melbourne, Fla.	Oct. 9, 1953	3.56	70-76	Einem, G. E.	Unpubl. data.
Gainesville, Fla.	Sept. 24, 1947	3.34	62-83	Goin, O., & Goin, C. J.	Unpubl. data.

	Mar. 9, 1948	2.13	58-80		
	April 5, 1949	4.85	62-70		
	Aug. 22, 1949	3.21	71-91		
	Sept. 5, 1950	5.60	73-75		
	Oct. 18, 1950	1.85	68-75		
	Sept. 18, 1951	2.18	70-85		
	Feb. 16, 1952	3.14	61-70		
	Mar. 11, 1953	2.51	62-69		
	April 7, 1953	4.58	62-73		
	June 14, 1953	3.70	66-85		
	June 25, 1953	1.70	72-94		
	Aug. 23, 1953	2.60	67-84		
DeLand, Fla.	Oct. 19, 1950	3.65	71-79	Hansen, K. L.	Unpubl. data.
	June 26, 1956	2.65	68-94		
	Oct. 15, 1956	3.00	75-78		
	May 19, 1957	3.56	68-91		
	July 2, 1957	2.75	78-96		
	Sept. 7, 1957	1.34	71-85		
	Sept. 29, 1957	-	-		
Gainesville, Fla.	Feb. 7, 1955	0.61	50-70		
Jacksonville, Fla.	Aug. 22, 1957	0.92	72-84		
Lakeland, Fla.	Jan. 16, 1955	0.39	55-75	Ober, D.	Unpubl. data.
Micanopy, Fla.	Sept. 22, 1951	1.61	73-94	Pearson, P. G.	Ecol. Mong. 25:233-67.
Gainesville, Fla.	July 14, 1955	-	-	Twente, J.	Unpubl. data.
Gainesville, Fla.	March 18, 1923	-	-	Van Hyning, T.	Copeia 1923(118):68.
Hillard, Fla.	Aug. 16-17, 1922	2.01	69-91	Wright, A. H.	Life histories of frogs of Okefinokee Swamp.
Macon Co., Ala.	May 1953	-	-	Brown, J. S.	Unpubl. data.
Crenshaw Co., Ala.	Mar. 13, 1954	-	-		
Tuscaloosa Co., Ala.	May 1954	-	-		
Harrison Co., Miss.	Mar. 1931	-	-	Allen, M. J.	Am. Mus. Novitates 542:1-20.
Biloxi, Miss.	Feb. 6, 1955	1.42	52-68	Euenzler, E. J.	Unpubl. data.


SPADEFOOT BREEDING CHORUSES
MONTHS HAVING GREATEST RAINFALL IN YEAR (1892 - 1954)
MONTHS HAVING GREATEST RAINFALL IN 24 HOURS (1893 - 1954)
NORTHEASTERN STATES
MIDDLE EASTERN STATES
SOUTHEASTERN STATES
J F M A M J J A S O N D

Upper. Correlation of breeding by *Scaphiopus h. holbrooki* with heavy rainfall in the State of Florida.

Lower. Monthly breeding records of *Scaphiopus h. holbrooki* from the northern, central, and southern portions of its geographic range.

In the northeastern states (Mass., Conn., and N.Y.), breeding is limited to five months from Apr. through Aug. Toads of the middle eastern states (N.J., Penn., Ohio, Ind., Md., Va., W.Va., Ky. and N.C.) breed over a six month period from Mar. through Aug. Breeding in the southern states (S.C., Ga., Fla., Ala. and Miss.) extends eleven months from Dec. through Oct. Although breeding has not been reported for Nov., it is almost certain that it occurs during all months of the year in the south. Low temperatures from Sept. to the following spring is undoubtedly the factor preventing fall and winter breeding in the north and middle eastern states.

9. In Fla., breeding starts in Jan. and builds up to a peak in Sept. and Oct. Figure 2 shows that breeding is correlated with increased rain in Fla. in the fall. Hurricane rains in Aug., Sept., and Oct. have accounted for 6 of the 18 choruses during these months.

10. From these data, it is clear that the eastern spadefoot does not follow a seasonal breeding pattern as found in most Anura. Rather, it would seem that breeding can occur in any month if heavy rain and warm temperature prevail.

The question arises as to why the spadefoot does not follow a cyclic, seasonal pattern of breeding as found in most eastern Anura. The answer is probably to be found in the phylogenetic history of the genus *Scaphiopus*. Both Tanner (1939) and Bragg (1945) postulate the origin of the genus under xeric conditions in southwestern North America. The fossorial and nocturnal habits of the group is in accord with this hypothesis. Living in this area for a sufficient time, they established a xeric pattern of breeding, characterized according to Bragg (1945), by lack of a definite breeding season, breeding behavior being initiated by heavy rain and use of temporary water only. Having established fossorial, nocturnal and xeric-breeding behavior, the genus spread north and eastward. Thus the breeding pattern of the eastern form, *holbrooki,* has always been difficult to understand because of its desert breeding pattern in a mesic environment where most Anura breed seasonally.

One apparent problem is the physiological capability of males and females to breed any time of year. During a study (Aug., 1954—July, 1955) of a population near Gainesville, Fla., female toads were found to carry ova throughout the year, but no breeding occurred. To test whether the maturation of ovaries was seasonal, a comparative study of the ratio of ovary to body weight was made, Table 2. The means for Dec. and Apr. showed the widest range, but a statistical comparison failed to show a significant difference ($P > 0.05$). It was concluded that in the absence of ovulation, females carry a full complement of mature ova through the year.

During the same period, males were tested for their retention of sperm. Each month, two males were injected with one male spadefoot pituitary. Spermiation resulted in every case, indicating that viable sperm were present in the testis throughout the year. This would indicate that fertilization of ova under natural conditions is possible at any time.

Since spadefoots are known to go two and three years without breeding, the question arises as to the length of time that females can retain their ova. Rugh (1951) reports that if a female *Rana pipiens* is forced to retain her eggs beyond the normal breeding period, the ova cytolize in the

ovary. Although the spadefoot is able to retain a full complement of mature eggs for some time, post-mature ova might be replaced by newly developing eggs, since even the most mature ovaries possess some immature eggs in various stages of development.

TABLE 2

Ratio of Ovary Weight to Body Weight for *Scaphiopus h. holbrooki*

Month	Number of Individuals	Mean Percentage Ovary: Body Weight
August, 1954	12	14.8
September, 1954	18	15.9
October, 1954	31	15.7
November, 1954	18	16.5
December, 1954	13	14.0
January, 1955	15	15.5
February, 1955	25	14.7
March, 1955	17	15.7
April, 1955	13	17.2
May, 1955	20	16.5
June, 1955	11	15.3
July, 1955	12	16.6

A final problem concerns the environmental stimulus required to initiate breeding. Most anurans follow a rhythmic seasonal breeding cycle in which the rise in air and water temperature seem to initiate breeding. The gonads undergo a seasonal hypertrophy and mature in the spring, following winter hibernation. Since the spadefoot breeding pattern does not follow a cyclic pattern and males and females carry viable gametes throughout the year, it is almost certain that the breeding stimulus is environmentally induced. Since relatively warm temperatures are necessary for the functioning of ectothermal animals, the only major environmental factor for consideration is heavy rain.

How might rain stimulate the physiology and behavior of the toad and thereby cause a breeding reaction? In a study of *in vitro* ovulation, it was possible to demonstrate that physiological water-uptake in females stimulated significantly greater percentages of ovulation than in control toads having had no water-uptake (Hansen, 1955). This work seemed to offer evidence that water-uptake stimulated the gonads. It is possible that the water-regulatory function, controlled by the *pars nervosa* of the pituitary and the ovulatory regulation, controlled by the *pars distalis*, are closely related. I hypothesize that a hypotonicity of body fluids due to water-uptake stimulates the anterior lobe of the pituitary to hypersecretions of gonadotropins.

Males also require water-uptake, for it has been shown that pituitary-injected male anurans fail to release sperm, even after histological spermiation has occurred, when insufficient body fluids prevent urine formation (Valle, Penhos, and Houssay, 1952).

From this point, the writer would like to postulate, in accordance with experimental and field observations, on what are believed to be the steps involved in spadefoot breeding. In their burrows, toads are subjected to

desiccation or hydration depending upon the soil moisture. When rainfall is sufficient, water-uptake occurs in both sexes. Sensitized by water-uptake, the toads are physiologically conditioned for breeding by a release of gonadotropins from the pituitary. This breeding sensitivity can only be fulfilled when toads living in low areas are flooded from their burrows by temporary pools covering them. These toads are probably the initiators of the breeding chorus, entering amplexus while floating at the surface of the collecting water. Free males utter loud harsh calls, possibly stimulating females and other males to join the breeding chorus.

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SOME FEEDING HABITS OF THE EASTERN HOG-NOSED SNAKE.—On Sept. 13, 1956, a hatchling *Heterodon platyrhinos platyrhinos* Latreille, was captured by Mr. H. B. Smythe at Glen Este, Ohio, near a spring where small frogs were abundant. Observations of its habits were made during the next ten months. It fed avidly on any small frogs offered. Occasionally when frogs were not plentiful it could be induced to eat a small piece of raw meat if it were first aroused by a live frog moving about in the cage and then substituting the meat. At such times it appeared to rely on both sight and smell in feeding. It could not be aroused merely by making the meat "jump" by means of a thread. When a frog was placed in the cage, the snake, if hungry, immediately became alert indicating an olfactory perception. However, if the frog remained motionless, it was difficult for the snake to locate it. Sometimes it would crawl over the frog and not strike, but when the frog would jump, the snake would strike. If it missed and the frog remained motionless, the snake could not readily find it. At such times it appeared to rely mainly on visual perception and would strike at any moving object and thus could be induced to accept meat. From 9-13-56 to 7-4-57 it ate 33 *Acris gryllus,* 1 *Pseudacris nigrita,* 5.3 g meat and 1 dead *Plethodon cinereus.* It was induced to eat the latter by the same means employed with the meat. Since *Acris* were much more plentiful than small *Bufo,* it was never offered any of the latter.

On May 18, 1957, when put in a terrarium with two full grown *Bufo woodhousei fowleri,* it became excited, grabbed one and held on although it was not nearly large enough to swallow it. When the observer separated them, the snake repeatedly returned and grabbed one or the other of the toads until it was moved to another cage. It apparently suffered no ill effects although the skin of the toads came in contact with the lining of the mouth.

These observations indicate that *Heterodon platyrhinos* is inherently resistant to toad poison and that the resistance is not an individual adjustment as suggested by Smith and White (1955, Herpetologica 11: 143), since this specimen had certainly not been exposed to toads during the period of captivity and probably not for its entire life, yet it withstood the full potency of the skin venom of adult toads.—*James E. Huheey, Museum of Natural History, University of Illinois, Urbana.*

TIMBER RATTLESNAKE IN JEFFERSON COUNTY, ILLINOIS. —In Aug., 1957, a male *Crotalus h. horridus* was collected near a rocky ravine in NW Jefferson Co., Ill. The last authentic record from that county was published by Garman, 1896. I find no records from adjoining counties. The specimen is in the writer's collection. Ground color yellow; bands dark brown; tail black; six rattles; length 56 in.; circumference at midbody 8 in.; weight at capture 5 lbs.

This note was submitted to Dr. L. M. Klauber who writes April 13, 1958. "I did not have a prior record from Jefferson Co., but I did have records from 20 other Illinois counties, several of them near Jefferson." —*Eugene T. Estes, Community High School, Woodlawn, Ill.*

A New Frog of the *auriculatus* Group of the Genus *Eleutherodactylus* from Western Cuba

By ALBERT SCHWARTZ

The *auriculatus* group of leptodactylid frogs in Cuba as defined by Dunn (1926: 210) is characterized by enlarged digital discs, rugose belly and short vomerine tooth series. As currently understood, there are five forms in this group: *Eleutherodactylus auriculatus auriculatus* Cope, *E. a. sonans* Dunn, *E. varians* Gundlach and Peters, *E. eileenae* Dunn and *E. gehrmanni* Schwartz. The arrangement of trivial names above is that of Barbour (1937) except the more recently described *gehrmanni*. At the time of Dunn's (*op. cit.*) summary of the Cuban forms of *Eleutherodactylus*, several were known from limited material; for example, *E. a. auriculatus* was represented by only three specimens, *varians* by two and *a. sonans* by 20. *E. gehrmanni* was later described (Schwartz, 1958) on one specimen. Only *eileenae* was amply represented in collections at the time of Dunn's review.

Collections, which form the basis of this paper, were made during the summer of 1957 and December-January 1957-58, under a National Science Foundation research grant. During these field excursions I have had the unflagging assistance of several students, through whose aid the large lot of material taken has been amassed; to the following men I owe a sincere debt of gratitude: Edwin B. Erickson, John R. Feick, William H. Gehrmann, Jr., Dennis R. Paulson, Willard M. Stitzell, Richard Thomas and George R. Zug. All are especially to be commended in that, since members of the *auriculatus* group are, insofar as known, arboreal, their collection is often exceedingly difficult, and the pursuit of such unrewarding game is at times most discouraging. I wish also to thank the following for loan of pertinent material in their care, or for offering me facilities to work at their respective museums: Mr. Charles M. Bogert and Dr. Richard G. Zweifel, American Museum of Natural History (A.M.N.H.); Dr. Ernest Williams and Mr. Benjamin Shreve, Museum of Comparative Zoology (M.C.Z.); Dr. Norman E. Hartweg, Mr. Richard Etheridge and Mr. Thomas M. Uzzell, Jr., Museum of Zoology, University of Michigan (U.M.M.Z.); Dr. Doris M. Cochran, United States National Museum (U.S.N.M.). Mr. Jerry D. Hardy, who has made extensive collections in Las Villas and Oriente provinces in Cuba and whose material is deposited in the United States National Museum, has also graciously allowed me to examine his eleutherodactyli and comments are drawn from these specimens in the present paper.

Dunn (1925: 164-65) described *E. sonans* as a full species; the type locality is Soledad, Las Villas Province. He commented on the close relationship of this form to *E. auriculatus*, but gave a list of distinguishing features, not the least of which in importance is the much smaller size of *sonans* as compared to *auriculatus*. Apparently, there were nine specimens from Soledad (including type) available to Dunn in 1925. In 1926, only a few more specimens were at hand; these included two from Pinar del Río (Rangel), seven from Las Villas (Soledad, Mina Carlota) and two from Oriente (Baracoa). The form was

thus shown to have a wide distribution, from the eastern portion of the island to the west as far as Rangel in Pinar del Río. In the same paper (1926: 212) Dunn commented on having seen only three specimens of *E. auriculatus*; two from "Eastern Cuba", which had been collected by Charles Wright and hence probably to be regarded as topotypes and another from Monte Libano near Guatánamo, all from Oriente Province. Thus, Dunn regarded *sonans* and *auriculatus* as distinct species, the former very widespread throughout Cuba, the latter restricted to Oriente. Barbour *(op. cit.*: 97) placed *sonans* as a subspecies of *auriculatus,* stating that *a. auriculatus* is the characteristic form of eastern Oriente and *a. sonans* the central Cuba representative of the same species. This action was taken despite Dunn's records of *sonans* from Baracoa (which is in extreme eastern Oriente) and despite the great disparity in size between the two forms.

I have not collected specimens of *E. a. auriculatus,* but have examined the following material, all from the province of Oriente, Cuba: Gran Piedra Range, 2000′-3000′, 5 (MCZ 2129-33); Upper Ovando River, 1000′-2000′, 2 (MCZ 22160-61); Cobre Range, 3000′-3800′, 1 (MCZ 22139); El Perú, Mt. Libano, Guatánamo, 1 (MCZ 3117); nr. Cueva del Aura, Pico Turquino, 1500′-4000′, 5 (MCZ 21985-89); Cueva del Aura, Pico Turquino, 1 (USNM 137914); coast south of Pico Turquino, 12 (MCZ 22060-05, plus six untagged specimens); mountains north of Imías, 6 (MCZ 22104-09); El Yunque de Baracoa, 4 (MCZ 22066-69); Pico Turquino, 4 (UMMZ 80907; USNM 137915). With two exceptions, these are all old specimens and little can be gained from them regarding pattern. The only feature which is discernible is the rather regular occurrence of a white or pale interocular bar, usually rendered more distinct by anterior and posterior dark outlining. The dorsa are either uniformly tan, or lightly speckled with slightly darker brown on a tan background. The two fresh specimens (USNM 137914-15) are both poorly preserved, but show some indication of the white interocular bar and a much flecked or dotted dorsum. The hindlimbs appear to be unicolor.

As Dunn has pointed out, *E. a. auriculatus* is a frog of moderate size; he (1926: 211) gave maximum size for males as 38 mm. I have examined no males reaching that size; the maximum size of males measured by me is 30.2 mm. and of females 40.0 mm.

E. a. sonans on the other hand shows an entirely different dorsal coloration. I have collected 29 specimens from the provinces of Pinar del Río, Habana, Las Villas and Camagüey. In life, the dorsum is some shade of brown, often with a median dorsal pale hairline, light snout and usually a pair of dusky dorsal chevrons, their apices directed anteriorly. The legs are often banded. The largest male measured has a snout-vent length of 19.7 mm., and the single female (which is gravid) measures 18.9 mm. Structurally, *sonans* and *a. auriculatus* are quite similar, but the differences in size and pattern, as well as the sympatric distribution of the two forms in Oriente, indicate to me that *sonans* is not a race of *E. auriculatus,* but is rather a distinct small species of the *auriculatus* group.

The third member of the *auriculatus* group, *E. varians,* has been known from extremely limited material. The only specimen available

to Dunn with precise locality data was from Soledad, Las Villas. I have examined this specimen (MCZ 11131), as well as a cotype of *varians* (MCZ 11621). These two individuals are the only specimens in museums in the United States; five specimens (UMMZ, 98022) previously dubiously referred to *varians* by me (Schwartz, 1958:6) are definitely not this species, but possibly represent a record of *E. eileenae* from Oriente. These specimens are in poor condition and their precise allocation must await additional material from the easternmost province.

During the summer of 1957, *E. varians* was collected in Pinar del Río, Las Villas, and Camagüey. It has proven extremely difficult to collect, although calling males are often very abundant in deciduous forest. Males vocalize from the trunk and branches of high trees, as well as from bromeliads; the call is a penetrating and at times almost deafening, sharp metallic sound, and, because of the height from which the males call, has a distinctly ventriloqual quality. We have been very fortunate in collecting 15 of this rare amphibian, all adult males except one immature female. This collection of *E. varians* depends upon locating males which are calling either from bromeliads on fallen trees in the forest, or upon finding a male calling from the trunk of a standing tree at a height which is within relatively easy reach. Several of our specimens were taken by climbing trees, a task which proved not only arduous but dangerous as well and in general unsuccessful, since the frogs, even after a heavy rain, are rather shy and any disturbance of the branch upon which they are resting will cause them to become silent. At San Vincente, Pinar del Río Province, *E. varians* was relatively easy to capture, since here the steep sided *mogotes,* with vegitation on the sides, allow ascent over the *mogote* face, so that the collector eventually reaches the level of the tops of the trees and may take specimens without climbing the trees themselves and thus with no disturbance to the calling leptodactylid. Also at San Vincente, it was noted that *E. varians* called from lower vegetation and it was not unusual to find the males calling from the large fronds of low palms *(Gaussia princeps, Thrinax microcarpa).*

The relationships between *E. varians* and *E. a. auriculatus* are as yet uncertain. Structurally, they are to me indistinguishable. Dunn (1926: 211) differentiated between the two species on the basis of the size of the tympanum and the size of the digital discs; that these characteristics do not apply when large numbers of specimens are compared is not surprising, considering the very limited amount of material of both these forms which was available to Dunn. *E. varians* is an exceptionally beautiful frog in life, the dorsal pattern made up of irregular blotches of silvery-white and tan; as noted above, the coloration of *E. a. auriculatus* is unknown. Although it may be premature at this time to regard these two forms as conspecific, it seems appropriate because of the great structural similarity between them. It may well be that, with collection of additional material from Oriente and Camagüey, it will be discovered that *varians* and *auriculatus* are distinct, but such a position is untenable at the present time.

E. eileenae Dunn has been known only from Pinar del Río and Las Villas (Dunn, 1926: 212). Of this species, Dunn had 71 specimens. It is an extremely common frog in the Sierra de los Organos and Sierra del

Rosario in Pinar del Río, as well as in the Sierra de Trinidad in Las Villas; that it is not restricted to these two provinces is shown by specimens collected in the summer of 1957 in Camagüey. It likewise is arboreal, but both structurally and chromatically, as well as vocally, it is quite distinct from the remaining members of the *auriculatus* group. *E. gehrmanni* Schwartz *(op. cit.*: 4) was described on the basis of a single female from Pinar del Río; of the many specimens of *eileenae* recently collected and handled, no individuals with the precise coloration of the type of *gehrmanni* have been observed. The differences between *gehrmanni* and *eileenae* involve, in addition to coloration and pattern, the possession by the former of an indistinctly granular dorsum (warty in *eileenae).* In proportions, the two forms are alike and both have banded hind limbs. I feel that *E. gehrmanni* is an abnormally less warty specimen of *E. eileenae;* the differences in coloration, which are pronounced, may be of less importance than previously assumed, since *eileenae* is noteworthy for the variety of colorations and patterns it exhibits. Accordingly, I regard *E. gehrmanni* Schwartz at present as a synonym of *E. eileenae* Dunn.

In light of the above remarks, I currently regard the members of the *auriculatus* group of Cuban *Eleutherodactylus* as composed of the following forms: *E. auriculatus auriculatus* Cope; *E. a. varians* Gundlach and Peters; *E. sonans* Dunn; *E. eileenae* Dunn.

As mentioned above, specimens of *E. a. varians* were collected in three Cuban provinces. Seven adult males from Pinar del Río differ in details of pattern and size from specimens from Las Villas and Camagüey. For reasons noted below, these latter specimens are regarded as typical of the race *varians* as described by Gundlach and Peters. Since the Pinar del Río material is distinctly different from both *E. a. auriculatus* from eastern Cuba and *E. a. varians* from central Cuba, I regard it as representing a new subspecies which may be called

Eleutherodactylus auriculatus olibrus, new subspecies

Type: AMNH 61155, an adult male, taken at cliffs at Cueva del Cable, San Vincente, Pinar del Río Province, Cuba, by William H. Gehrmann, Jr., and Albert Schwartz, June 29, 1957. Original number 2136.

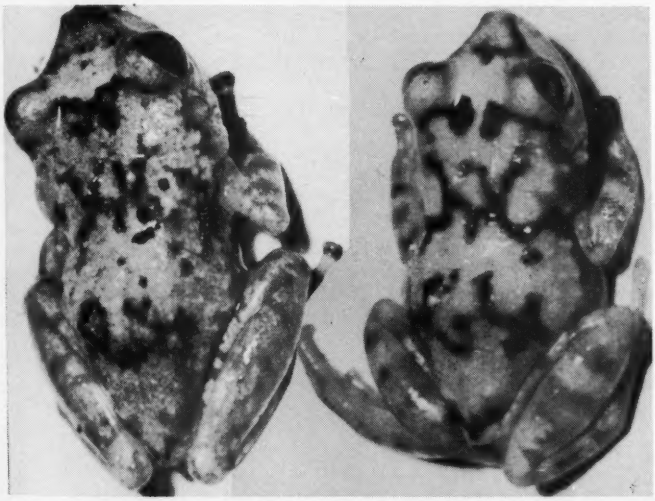
Paratypes: AMNH 61149-53, adult males, taken at cliffs above Cueva del Río, San Vicente, Pinar del Río Prov., Cuba, John R. Feick and Armando García, June 20, 1957; AMNH 61154, adult male, same data as type.

Distribution: known only from the vicinity of the type locality, but presumed to occur throughout the Sierra de los Organos and the Sierra del Rosario in western Cuba.

Diagnosis: A subspecies of *E. auriculatus,* differing from *E. a. varians* in metallic tan rather than pearly white dorsal ground color, in having unicolor tan hindlegs, and shorter fourth toe, and from *E. a. auriculatus* in generally smaller size, especially narrower head, smaller eye, shorter tibia and fourth toe, as well as having a blotched rather than a unicolor, flecked, or dotted dorsum.

Description of type: An adult male, with the following measurements (in millimeters): snout-vent length, 25.7; length of head from snout to posterior border of tympanum, 9.4; greatest width of head, 10.8;

longitudinal diameter of eye, 3.7; longitudinal diameter of tympanum, 1.4; naris to eye, 3.1; femur, 12.1; tibia, 12.6; fourth toe, 9.6. Head broader than distance from snout to posterior border of tympanum; snout rather acute with nares conspicuous at anterior end of canthus rostralis; diameter of eye larger than distance from naris to anterior corner of eye; interorbital space 4.0, a bit larger than diameter of eye; diameter of tympanum much less than diameter of eye, distance from tympanum to eye slightly less than diameter of tympanum. Digital discs present, large and prominent, that of digit 3 the largest and equal to about one-half size of tympanum. Fingers relatively short, unwebbed, 3-4-2-1 in order of decreasing length; subarticular tubercles poorly developed, not gray and unicolor with undersurface of hand. Toes short, unwebbed, 4-3-5-2-1 in order of decreasing length; subarticular tubercles poorly developed. Heels overlap when legs are held with femora at right angles to body axis. Dorsum very finely shagreened. Throat and chest smooth, with extensive gular vocal sac extending posteriorly to behind insertion of forelimbs; belly heavily rugose. Posterior surface of thighs covered with smooth, flattened, pavement-like granules. Tongue large, oval, slightly nicked posteriorly, free behind, its greatest width almost equal to that of floor of mouth. Vomerine teeth in two short, very slightly bowed, series, situated well within and behind the inner



Left. *Eleutherodactylus a. olibrus,* type, AMNH 61155, adult male, snout-vent length 25.7 mm. Print from Kodachrome taken in life by William H. Gehrmann, Jr.

Right. *Eleutherodactylus a. varians,* AMNH 61158, adult male, snout-vent 29.3, from 8 mi. S. Manicaragua, Las Villas Prov., Cuba. Print from Kodachrome taken in life by William H. Gehrmann, Jr.

margins of the choanae and separated from them by a distance equal to the length of a series and from each other by a distance equal to the combined lengths of both series.

Coloration of type (based on Kodachrome photographs from life): Ground color of dorsum metallic bronze; a prominent, slightly paler, but equally metallic, interocular band, involving entire upper eyelid and expanded centrally with a posterior median projection; interocular bar outlined anteriorly with tan and posteriorly with brown, expanded medially to form two brown ovals on either side of dorsal midline. Snout tan, lores metallic bronze; a brown canthal line extending from snout through naris to anterior corner of eye, and from posterior corner of eye above tympanum to above insertion of forelimb. Dorsum mottled with tan on bronze ground color, with an irregular seven-pointed scapular bar adjacent to a brown irregular spot above forelimb insertion; an irregular sacral blotch of tan color; bronze areas with tan dots or flecks scattered within them. Dorsal surfaces of forelimbs bronzy with three brown distinct transverse bands on antibrachium; brachium unicolor bronze. Hindlimbs bronzy with very faint tan mottling, not organized into bands; concealed surfaces of thighs pale yellow. Fingers and toes lighter than dorsal ground color, almost white, with a dusky overlying suffusion (Fig. L.). Throat yellow, with scattered brown chromatophores, more concentrated along margins of jaw; belly somewhat paler with scattered brown chromatophores over entire surface, gradually merging into the darker lateral brown color.

Variation: The paratypes include six adult males, collected while calling.

The measurements of seven specimens (type and paratypes) are: snout-vent length, 26.2 (25.2–28.2); head length, 9.7 (9.4–10.0); head width, 10.6 (10.1–10.9); diameter of eye, 3.6 (3.4–3.8); diameter of tympanum, 1.5 (1.4–1.6); naris to eye, 3.2 (3.0–3.5); femur, 11.2 (10.6–12.1); tibia, 12.3 (11.7–12.8); fourth toe, 9.3 (8.5–9.6). The paratypes agree closely with the type as far as structure is concerned. As regards coloration and pattern, there is some variation. The ground color of the dorsum is always bronzy, and the interocular bar is present and usually well defined, although it may be somewhat less pronounced than in the type because of a slightly darker dorsal ground color. The precise configuration of the scapular and sacral blotches varies greatly, but both are demonstrated in all specimens. In AMNH 61153 the sacral blotch is reduced to many small spots or dots. The hindlimbs are never barred or prominently blotched, and may be unicolor (AMNH 61150) or very faintly mottled (AMNH 61151). The concealed surfaces of the thighs varied in life from yellow to tan. The iris is metallic gold above and brown below. The frogs had distinctly yellow (Pl. 18, L1; color designations from Maerz and Paul, 1950) throats in life, with the belly and undersides of fore- and hindlimbs somewhat paler yellow. All the paratypes show scattered brown chromatophores on the ventral surfaces, becoming more concentrated along the margin of the lower jaw. Although not so well displayed in the type, all paratypes have two areas, which are presumed to be glandular, on the posterior portion of the vocal sac; these areas are highly pigmented with yellow chromatophores in life, and are still discernible in preserved specimens.

Comparisons: In addition to the two old specimens of *E. a. varians* mentioned above, I have examined the following specimens taken during the 1957-58 collecting season: *Las Villas,* 8 mi. S Manicaragua, 3 (AMNH 61156-58); 4 km. W, 8 km. N Trinidad, 3 (AMNH 61159-61); *Camagüey,* 5.5 mi. NE Banao, Paso de Lesca, Sierra de Cubitas, 2 (AMNH 61162-63). That these specimens are similar to the original material of *E. varians* as described by Gundlach and Peters (1865: p. 391) is shown by their comments that *Hylodes varians* has (translated) "more or less distinct crossbands on the extremities" and the "venter brown or gray". The six specimens from Las Villas, all from the Sierra de Trinidad, show the distinctly banded or blotched condition of the hindlimbs; the venters in all are more heavily stippled with brown chromatophores than *E. a. olibrus,* and, in extreme instances, have a distinctly darker hue.

In size, *E. a. varians* is slightly larger than *olibrus,* although the differences are more pronounced in life than in preserved specimens. Measurements of seven adult males are as follows: snout-vent, 27.8 (26.8–29.3); head length, 10.1 (9.4–11.2); head width, 11.1 (10.0–12.5); diameter of eye, 3.5 (3.2–4.0); diameter of tympanum, 1.6 (1.4–1.8); naris to eye, 3.4 (3.2–4.0); femur, 11.8 (10.9–12.5); tibia, 12.6 (11.8–13.6); fourth toe, 10.6 (10.1–11.2). In all cases except diameter of eye, *varians* averages larger than *olibrus;* the length of the fourth toe separates the two forms without difficulty. Structurally, the two subspecies are very similar.

A striking color difference between *varians* and *olibrus* which is very apparent in life is that the ground color of the former is silvery-white rather than bronzy. Thus the dark dorsal blotching of *varians* is much more apparent than the blotching of *olibrus,* and the hindlimb bands likewise are rendered prominent because of the silver ground color. In general, the thighs are marbled with brown, the crus and pes crossed by brown bands on a silver ground color. In life, the venter and concealed surfaces of thighs of the Sierra de Trinidad specimens were yellow (Pl. 9, L6 in the juvenile female), and there was a spot of yellow in the axilla.

The two specimens from Camagüey deserve special mention. One of these (AMNH 61162) was dead upon preservation, and now no evidence of pattern remains except for a faintly indicated ocular bar; the other individual (AMNH 61663) is in good condition, and shows a dorsal pattern different from all other *varians* studied. In this frog, the dorsal blotching is very pronounced, there being no exposed areas of ground color, except for pale dorsolateral lines; the hindlimbs are neither unicolor as in *olibrus* nor so prominently banded or blotched as in typical *varians,* but rather show distinct punctations or fine stippling. It is possible that the Camagüey population of *E. auriculatus* are intergradient between *varians* and the more eastern *auriculatus,* but additional specimens are badly needed for crucial areas.

Comparison between *E. a. olibrus* and *E. a. auriculatus* is made extremely difficult since no well preserved fresh material of the latter subspecies is at hand. Thus no comments on the comparison of markings and coloration of the two forms can profitably be made. However, judging from available material, *olibrus* differs from *auriculatus* in having

a blotched, rather than a unicolor or flecked dorsum. Three male *auriculatus* have the following measurements: snout-vent, 27.2 (25.1–30.2); head length, 10.4 (9.6–11.7); head width, 11.9 (11.3–13.0); diameter of eye, 4.2 (3.7–4.6); diameter of tympanum, 1.6 (1.3–1.9); naris to eye, 3.3 (3.2–3.4); femur, 12.6 (11.8–14.0); tibia, 14.2 (13.7–14.8); fourth toe, 10.4 (9.8–11.4). Compared to *olibrus, auriculatus* is seen to be larger in measurements of head width, diameter of eye, femur, and tibia. Remarkably, the majority of *E. a. auriculatus* which I have examined are females, and thus comparisons between this subspecies and *olibrus* is rendered much more difficult since females of the latter are as yet unknown.

There are three races of *E. auriculatus* on other islands in the West Indies: *auriculatoides* Noble and *wetmorei* Cochran from Hispaniola, and *portoricensis* Schmidt from Puerto Rico, St. John, and Tortola. According to Cochran (1941) there are other Hispaniolan species *(montanus, armstrongi)* which may well be closely allied with *E. auriculatus.* I do not know these subspecies in life, and thus comparisons between them and *olibrus* are made on the basis of published descriptions. From *portoricensis, olibrus* differs markedly in dorsal pattern, and does not demonstrate, insofar as known, a comparable variety of dorsal patterns. The Puerto Rican subspecies likewise has a *dark* rather than *light* interocular bar. From *auriculatoides, olibrus* differs in dorsal pattern and in having a light, rather than dark, interocular bar. The race *wetmorei* resembles *olibrus* in having a light interocular bar, but differs in having the posterior surface of the thighs coarsely reticulate with dark brown blotches on a light background, as well as having blotches on the anterior face of the thigh and near the groin on the sides.

Comparison with other members of the *auriculatus* group is simple. From *E. sonans, E. a. olibrus* differs in larger size and blotched rather than linear dorsal pattern. The voices of these two forms are very distinctive, and will be discussed at length in future publications. From *E. eileenae,* the only remaining Cuban member of the group, *E. a. olibrus* differs in stouter build, shorter and unicolor hindlimbs, larger discs, and different dorsal pattern. Again, these two forms are distinct vocally, although the calls of *olibrus* and *eileenae* are more similar than the call of the former and that of *sonans.*

Remarks: Like *E. a. varians* (and *E. a. auriculatus?), E. a. olibrus* is completely arboreal. Although known only from the type locality, vocalizing males of this species (and probably of the race *olibrus)* have been heard in Pinar del Río at Cueva de Santo Tomás, 10 km. N Cabezas, on June 22, 1957, during the day after a very heavy rain, and at Soroa on August 30 and 31, 1957. Near the type locality in the Sierra de los Organos, *olibrus* was extremely abundant, and the mountains and *monte* resounded with their metallic calls during the period of June 17 to July 10, 1957. On December 22, 1957, *olibrus* was calling along the river just north of San Vicente in some numbers, but none was heard on the *mogotes* as in the summer months.

The area of intergradation between *olibrus* and *varians* is unknown. That some subspecies of *auriculatus* occurs between the known range of *olibrus* and that of *varians* in Las Villas Province is manifested by calling males heard on the Carretera Central between Madruga and Ceiba Mocha in Habana Province, and 6.8 mi. W Jaruco in the same province. It is

possible that these Habana populations are intermediate between *olibrus* and *varians*, or they may be assignable to one or the other form. Although one gains the impression that *olibrus* and *varians* are montane frogs, at least in Camagüey the latter was heard calling from along a lowland stream in dense forest, and it is possible that, prior to the deforestation of parts of the Cuban lowlands for the planting of sugar cane, these frogs were widespread in the tropical *monte*. Another possibility is that the frogs are indeed montane, and occur in lowlands only along wooded river bottoms of streams which drain montane masses. If the latter is the case, then subspecific differentiations of *olibrus* from *varians* is easily conceivable since the eastern terminus of the Sierra de los Organos-Sierra de Rosario mountain massif is separated by some 30 kilometers from the Escaleras de Jaruco and other associated minor ranges in central Habana Province.

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DEPARTMENT OF BIOLOGY, ALBRIGHT COLLEGE, READING, PENNA.

A SECOND INSTANCE OF ALBINISTIC TENDENCIES IN THE PACIFIC GOPHER SNAKE.—Albinism does not appear to be rare in nature, but records of snakes showing albinistic tendencies are infrequent. The low rate of incidence (one-tenth to one-hundredth of one percent of a wide-ranging population [Klauber, 1956, Rattlesnakes, 1: 199]), and the probable inability of albinistic mutants to compete with normal fellows, no doubt account for their infrequent appearance.

Albinistic individuals of the western gopher snake, *Pituophis catenifer*, have been reported twice. Klauber (*loc. cit. supra*) states that three specimens of *Pituophis c. annectens* from San Diego Co., California, have been at the San Diego Zoo; one of these was made the subject of some experimental genetic studies by the late Dr. Perkins, former curator of reptiles at the zoo. Also, Dr. Tracy Storer reported on an albinistic *Pituophis c. catenifer* collected more than 40 years ago in San Mateo Co., California (1916, Copeia, 35: 74).

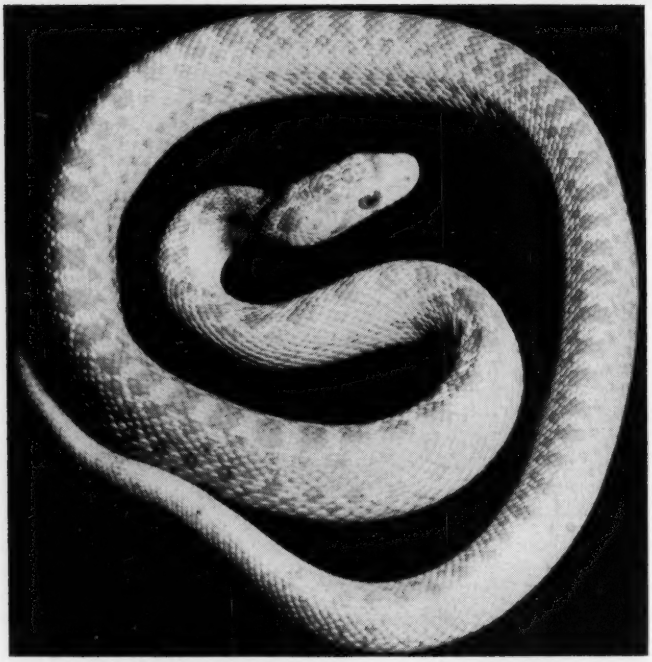

Figure 1. *Pituophis c. catenifer,* CAS 85185. Note absence of dark brown or black pigmentation in dorsal color pattern.

Recently a second specimen of *P. c. catenifer* showing albinistic tendencies was brought to our attention. It is a juvenile male, collected by Mrs. Anita Bucy at her residence approximately 3 mi. SW of Novato, Marin Co., California, and is now in the collection of the California Academy of Sciences (CAS 85185).

The color pattern of our specimen closely approximates that described by Storer. In both specimens all traces of melanin are absent; areas normally black are pale bluish to lavender, and the normally brown blotches on the dorsum and similarly colored stripe or bar markings on the head are light red. The ground color which usually is tan or yellowish brown is pale yellow. The iris and the tongue appear rather pinkish.

Irregularities in head scutellation in our specimen fall within the known range of variation for the subspecies. This individual measures 384.5 mm. in standard length (snout-vent), and 78.2 mm. tail length. *Alan E. Leviton, Calif. Acad. Sci., San Francisco 18, and Edward L. Kessel, Univ. of San Francisco, and Calif. Acad. Sci.*

Taxonomic Status of the Gray Tree Frog in Oklahoma[1]

By ARTHUR N. BRAGG

Herpetologists dealing with *Hyla versicolor* in Oklahoma have often wondered whether they had *Hyla v. versicolor* LeConte, *H. v. chrysoscelis* Cope, or an intergrading population. Most specimens have been designated *versicolor* (Bragg, 1948) but a few from the Southeast have been reported as *chrysoscelis* (Bragg, 1950). Since the type locality of *chrysoscelis* is Dallas, Texas, and *versicolor* ranges through the eastern United States, it seems reasonable to look east from Oklahoma in an attempt to analyze the population. The two forms can be separated with difficulty and the validity of *chrysoscelis* has been questioned. It seems necessary to compare specimens from well within the range of *versicolor* with topotypes and other specimens of *chrysoscelis* to make certain that the two differ and then to campare an extensive sample from Oklahoma with each.

Specimens of *versicolor* were secured from New England, New York, south to Mississippi, west to Wisconsin and Iowa. These were considered to be *versicolor.* Others were secured from northern and northeastern Texas (including some from Dallas). These, together with those reported by Bragg (1950) from southeastern Oklahoma, were assumed to be *chrysoscelis.* These series were compared with each other and with two other groups: (1) from Oklahoma exclusive of those mentioned above; and (2) from western Louisiana and adjacent southwestern Arkansas. The last series should represent *chrysoscelis* (Smith and Brown, 1947), but to be certain they were handled separately.

The following characters are commonly used to separate the subspecies:

versicolor

1. Dorsum rough (papillate, pustulate or rugose).
2. Posterior surface of thigh reticulated, rather than spotted, with brown and yellow, but with some variation. When spots occur, they tend to be large, seldom circular, or with small spots.
3. Male may average slightly larger (Wright and Wright, 1949; Bragg, 1950).
4. Voice may differ; higher pitched (Bragg, 1950).

chrysoscelis

1. Dorsum smooth.
2. Posterior surface of thigh essentially spotted with yellow or orange, on brown. Spots typically small to medium size, oval to circular. Occasionally reticulations may occur but usually more spotted than reticulate.
3. Male may be slightly smaller.
4. Voice may be lower (Bragg, 1948).

Data on 1, 2, and 3 were secured from each specimen and recorded on cards without reference to locality. The cards were then segregated into groups for comparison geographically. Measurements made were:

[1]Contribution from the Oklahoma Biological Survey and the Stovall Museum of Science and History, University of Oklahoma, Norman.

(1) snout-vent length to nearest mm.; (2) head-width at angle of jaws; and (3) shank-length. Values obtained were compared by statistical methods and possible variations in body proportions were tested by statistical comparison of ratios such as snout-vent length/head width or shank length. Data from males and females were handled separately.

Data on 2 could not be secured on a quantitive basis. There were so many variations in the specimens that some degree of subjective judgment was involved. A quasi-quantitive judgement was attempted by a scale of values from roughness to smoothness of the dorsum from *P* to *S* as follows: *P* unquestionably rough, papillate dorsum; P =essentially rough, but with papillae lower than in 1; Ps =essentially papillate, but papillae scattered or very low and/or small; Sp =basically smoother, but with either a few low papillae or with a very few in one or more small patches; S =with only a suggestion of papillation: *S* =absolutely smooth. Each group in each category was compared and then combined (*P* + P + Ps) = Pt, (Sp + S + *S*) = St. The occurrence of this character on a geographic basis was then determined. *P* and *S* were easy to judge; Ps and Sp were not. Another person might have put some Ps specimens into Sp or *vice versa.* Ps and Sp seem to show a valid trend because errors in either are as likely to occur in one direction as the other. Comparing Oklahoma specimens within the state (Table 2) I have combined the data into three groups (*S* + S; *P* + P; and PS + Sp = I), smooth, rough, and intermediate respectively.

Judgment of coloration on the thigh was subjective but each specimen was judged without knowing where it was collected. Any substantially consistent difference shown when the data were later grouped geographically should be valid.

418 adults were available, distributed as follows: 77 *versicolor* (48♂, 29♀); 70 *chrysoscelis* (60♂, 10♀), 14♂ and 1♀ were topotypes; 226 from Oklahoma (excluding known *chrysoscelis*) (205♂, 21♀); and 145 from Arkansas and Louisiana (28♂, 17♀).

Size: Forty-eight male *versicolor* ranged (R) in snout-vent from 28-57 mm.; mean (M) 44.81 and mode (Mo) 44. Fifty-four male *chrysoscelis* from Texas and southeastern Oklahoma gave R = 30-52; M = 41.69 Mo = 43. Twenty-eight female *versicolor,* R = 37-56 mm. snout-vent length; M = 48.17; Mo = 51. Corresponding values from ten female *chrysoscelis* were respectively R = 33-52; M = 43.80; and Mo = 47. If we express means to nearest mm., we have a 45 mm. *versicolor* contrasted with a 42 mm. *chrysoscelis* with corresponding females of 48 and 44 mm. Comparable modal values are 44 and 43 for males, 51 and 47 for females. Considering the ranges (R) it seems doubtful whether there is any difference in size between the two.

This is better shown in a comparison within the group considered as *chrysoscelis.* Fourteen, mostly toptopic, *chrysoscelis* males from Dallas, Texas and nearby Fort Worth averaged just over 44.29 mm., about the same as the mean for all other *versicolor.* Twelve from southeastern Oklahoma were smaller (M = 37).

Ratios: Standard statistical methods applied to ratios such as head-body/shank-length or head-width showed no significant differences.

Roughness or smoothness of dorsum: Table 1 shows the results on

a percentage basis. Comparing the column labeled Pt with that labeled St we find that 187 had some degree of roughness and 165 a greater degree of smoothness (53 + % and 47 — % respectively) among 352 without respect to sex or subspecies. But, if we break this down according to groups, almost 86% *versicolor* are essentially rough and 14% smooth, compared to 35% and 65% respectively for *chrysoscelis*. This is a significant difference despite the obvious variation shown in the other columns. There is only an average difference between the subspecies in degree of dorsal papillation. Some of the roughest were collected at Dallas, Texas and must be *chrysoscelis;* and one of the smoothest was from Vermont, *versicolor* without question.

Table 1. Degree of roughness or papillation of dorsum of 352 specimens. *P* = very rough, P = basically rough, Ps = many papillae present, but either low and small or scattered, Sp = having overall smooth appearance but with few papillae or many faint ones, S = smooth but with a very few papillae, *S* = absolutely smooth; Pt = *P* + P + Ps; St = Sp + S + *S*. Values are decimals of 1.0 (= 100%); numbers of specimens in each category are in parenthesis.

Category	*P*	P	Ps	Sp	S	*S*	Pt	St	Total
H. v. v.	0.167	0.803	0.033	0.367	0.454	0.181	0.857	0.143	1.000
	(11)	(53)	(2)	(4)	(5)	(2)	(66)	(11)	(77)
H. v. c.	0.280	0.440	0.280	0.413	0.239	0.348	0.352	0.648	1.000
	(7)	(11)	(7)	(19)	(11)	(16)	(25)	(46)	(71)
Okla.	0.077	0.385	0.539	0.500	0.383	0.117	0.409	0.591	1.000
	(5)	(25)	(35)	(47)	(36)	(11)	(65)	(94)	(159)
Ark.	0.032	0.743	0.226	0.286	0.714	0.000	0.689	0.311	1.000
La.	(1)	(23)	(7)	(4)	(10)	(0)	(31)	(14)	(45)
Total	0.068	0.318	0.145	0.210	0.176	0.082	0.531	0.468	0.999
	(24)	(112)	(51)	(74)	(62)	(29)	(187)	(165)	(352)

On this character, the 159 specimens from Oklahoma questionable as to subspecies were intermediates, approximately 41% rough (Pt) and 59% smooth (St) (Table 1). This is perhaps better indicated in the columns Ps and Sp which are borderline groups. Nearly 54% of all placed in Ps and 50% of those placed in Sp were Oklahoma specimens.

In 45 from Louisiana and Arkansas none was absolutely smooth (group *S*) but 71% in the slightly rougher group (S) occurred here. In the roughest (*P*) group only 3% came from this region but 74% occurred in the slightly rougher (P) group. Combined groups (Ps and Sp), approximately 69% and 31% respectively, indicated a greater degree of roughness in the sample.

Table 2 further breaks down the data from Oklahoma. Of 206 considered, 50 were from the northeastern quarter of Oklahoma, 108 from the southeastern quarter, and 48 from the central section (Cleveland and Pottawatomie counties). 92 were smooth, 67 rough, and 47 intermediates.

Table 2 shows no significant difference in this character on a north-

south basis. However, in the central part of the state approximately 63% (30 out of 48) were smooth, 15% (7) were rough, and 23% (22) were intermediate. Most of these specimens were collected from adjacent pools in Cleveland County near the Pottawatomie County line, so this result may indicate some tendency for smoothness or roughness of skin to be segregated in local areas, the smooth predominating here.

The Oklahoma population (at least as far as the sample shows) is intermediate in roughness and therefore intermediate between *versicolor* and *chrysoscelis*.

Table 2. Comparison to nearest percent of Oklahoma *H. versicolor* from various divisions of state. N = Oklahoma south of east-west line through Forth Smith, Arkansas. So. = south of this line. C = Central Oklahoma (Cleveland and Pottawatomie counties). 1.00 = 100%.

	N	So.	C	Total
S + S	0.36 (n = 18)	0.41 (n = 44)	0.63 (n = 30)	0.45 (n = 92)
P + P	0.36 (n = 18)	0.39 (n = 42)	0.15 (n = 7)	0.33 (n = 67)
Ps + Sp (I)	0.28 (n = 14)	0.20 (n = 22)	0.23 (n = 11)	0.23 (n = 47)
Total	1.00 (n = 50)	1.00 (n = 108)	1.01 (n = 48)	1.01 (n = 206)

Coloration on dorsal surface of thigh: In many specimens examined, colors had faded to dark and light. Light areas were assumed to represent the yellow or orange of the living animal. Careful notes were made as each specimen was measured before the locality was known. Each datum was recorded on a card and segregated geographically.

Great variation in coloration was apparent. One specimen from New England had a completely yellow (light) inner surface of the thigh; one from Texas was reticulate, about equally yellow (light) and dark; there were intermediate patterns, some with small circular spots of yellow on the brown, subcircular or circular areas or irregular patches of light or dark.

There was a tendency for most specimens in *chrysoscelis* to have smaller and more nearly circular spotting than in *versicolor* and Oklahoma specimens more nearly resembled the former. The Louisiana-Arkansas group was so variable that I could not place them.

Sexual dimorphism in *versicolor* is apparent only in the larger size of the female and by the vocal sacs and darker colored throat of the male. There seems to be no difference in coloration, papillation, or proportion.

I agree with Smith and Brown (1947) that *versicolor* and *chrysoscelis* should be retained as subsjecies but most of their basic differences are better expressed statistically than as absolutes. The size difference suspected by Wright and Wright (1949) and Bragg (1950) seems invalid. The subspecies are separated only on more intangible characters; roughness vs. smoothness of dorsum and coloration on posterior surface of thighs. Both are variable. Wright and Wright (1949) stated that *chrysoscelis* is essentially a smooth-skinned version of *versicolor.* This is correct if not taken too literally. The best morphological character is the most intangible; *i.e.,* the essentially spotted vs. essentially reticulate coloration of the thigh which separates a large percentage and seems to be the only character that does so.

Another important factor may also be a difference in the breeding call of the males.

The data indicates that the Oklahoma population is largely made up of intergrades (Fig. 1). Smith (1956) indicates that the Kansas population is *versicolor,* so the population in northeastern Oklahoma, nearly limited to the Ozark region, should be the same. The intergrading zone

Fig. 1. Distribution of Hyla versicolor in Oklahoma. Small stipples = basically *H. v. versicolor* LeConte but some may show slight influence from *H. v. chrysoscelis.* Large stipples = *H. v. chrysoscelis* Cope. Heavy line = approximate western limits of the species. Unmarked area east of line = intergrading zone between subspecies with most specimens more like *chrysoscelis* than *versicolor.*

begins at about the Arkansas River and extends southward to the edge of the valley of the Jack Fork near Page. LeFlore County. The population of this valley eastward to Mena, Arkansas is *chrysoscelis* (if the calls be really different). The only other area of Oklahoma where *chrysoscelis* occurs is in the Austroriparian life zone of extreme southeastern McCurtain County and up the valley of Little River north of Idabel (Bragg, 1948, 1950).

Conclusions

1. *Hyla versicolor versicolor* LeConte differs statistically from *H. v. chrysoscelis* Cope in having a rougher dorsum and a different pattern of coloration on posterior surface of thighs. A voice difference is suspected.
2. True *H. v. versicolor* in Oklahoma is limited to the northeastern Ozark region. True *H. v. chrysoscelis* is known in Oklahoma only in the valley of Jack Fork from about Page, LeFlore County eastward and in the Austroriparian life zone of southeastern McCurtain County with a narrow extension up the Little River valley north of Idabel.
3. The remainder of the Oklahoma population is intergrades between these with a slightly greater influence of the southern form predominating, especially in central rather than in southern Oklahoma as we might have expected. This probably indicates that local populations vary toward one subspecies or the other because of close interbreeding.

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A Discussion of the Polytypic Species, *Hypopachus Oxyrrhinus*, with a description of a New Subspecies

By FREDERICK A. SHANNON and FRANCES L. HUMPHREY

In 1940 E. H. Taylor (p. 520) described *Hypopachus ovis* from Tepic, Nayarit. No direct contrasts were made with the most closely related species, *Hypopachus oxyrrhinus,* but in 1948 Smith and Taylor (p. 95), in amplifying the description of *ovis,* differentiated it from *oxyrrhinus* on the basis of maximum size, which was given as 36 mm. for *ovis* as contrasted to 50 mm. for *oxyrrhinus,* as well as on the basis of color. *H. ovis* was described as having brown sides with white flecks contrasting with the dorsal coloration; an irregular dark line from occiput to groin; and dorsal coloration of grayish to gray-brown. *H. oxyrrhinus* was described as being large, "sides not dark brown in contrast to lighter dorsum but usually lighter; occasionally a few dorsolateral dark spots, and the diagonal lines sometimes indicated by a few dark spots."

Due to a breakdown in the color characteristics of the two species, considerable confusion has been experienced by the authors and others in correct allocation of individuals. Thus Peters (1954: 8, 9) experienced difficulty in allocating two specimens of *Hypopachus* from Buena Vista and San Salvador, Michoacán, to the correct species. His specimens were identified as *oxyrrhinus,* but he felt that the individual from San Salvador was close to *ovis* inasmuch as the sides were much darker than the dorsum and the stripe from occiput to groin was well marked and continuous across the legs. Peters listed the size of this latter specimen as 34 mm., and noted that *ovis* had not been reported from Michoacán. He states that Oliver (1937: 7) found what he called *oxyrrhinus* at Quesería, Colima, where Smith and Taylor (1948: 96) had listed only *ovis.* Peters found that Oliver's material did show a stronger resemblance to *oxyrrhinus* than to *ovis* in that the occiput-groin stripe was present and fairly complete in only four specimens of 14. The sides were lighter than the dorsum in ten and the same color or darker than the dorsum in four. There were several specimens larger than the 36 mm. maximum given for *ovis.* Peters points out that the range of *ovis* is quite similar to that understood for *oxyrrhinus* and that individuals answering the descriptions of each have been found together.

In an effort to determine relationships between these two presumed species, we have examined 84 specimens from the plateau area of Nayarit, Jalisco, and northwestern Michoacán from the collections of the senior author, the Texas Cooperative Wildlife Museum and the University of Illinois Museum of Natural History. Two paratypes of *H. ovis* (UIMNH 27290, 27293) from Tepic, Nayarit, were examined. Eleven measurements (head width; head length; total length; width of eye; eye-nostril; interorbital; dorsal nuchal fold to tip of snout; femur; tibia; foot) were made on 39 specimens. Examples of *oxyrrhinus* and *ovis,* FAS 8561 and 8566, were skeletonized. No significant differences in body measurements or skeletons were discernible.

Fourteen UIMNH specimens from Jalisco (40569, 8 mi NE. Lagos de Moreno; 40564-65, 45 mi. S. Guadalajara; 31274-84, near Chapala), all labeled *H. ovis,* were examined and ran the gamut of variation from

the pattern of *ovis* to that of *oxyrrhinus*. In the preserved specimens, seven had dorsums darker than sides, six had lateral surfaces darker than dorsum, as described for *ovis*, whereas one was dull dark above and on the sides. The light spots or areas in this latter specimen were so large that the interstices were reduced to almost linear reticulations. The lateral stripes varied from moderately distinct to absent and light spots in these stripes did the same. Variation in the spots consisted of meristic reduction or of variation in size, being reduced to powdery punctuations in a few. A minority of the specimens showed a tendency toward consolidation of dorsal dark spots into stripes running from occiput to groin. This stripe, best developed in UIMNH 31281, was broken into a series of dark spots. It should be mentioned that UIMNH No. 40569 from Lagos de Moreno, in the northern part of the state, differed from the other Jalisco specimens in having large, overlapping metatarsal tubercles, a larger web and a uniform dark back with no sign of lateral bands or light marks. Ventral light spots were indistinct, a variation not infrequently found in the southern part of the range.

Twenty-four UIMNH toads from Jalisco and Michoacán (Nos. 7838-39, 18.5 mi. NW Jacona, Michoacán; 7840-41, 6 mi. NE. Pátzcuaro, Michoacán; 31285-94, Autlán road, 7 mi. W. Autlán, Jalisco; 31295-31303, near Zapotiltic, Jalisco; 31304, 3 mi. E. Autlán, Jalisco), labeled *H. oxyrrhinus*, were examined. These also varied between a pattern fairly typical for *ovis* to that of *oxyrrhinus*. Six gravid females from near Zapotiltic and one from 3 mi E. Autlán varied in body length from 45 to 49 mm., whereas 11 males from near Zapotiltic varied from 33 to 38. It may be that the larger maximum size of 50 mm. listed by Smith and Taylor for *oxyrrhinus* is due to these gravid specimens. These large females are curiously similar in coloration, being rather uniformly dark brown above with lighter sides. However, four females have striking black bands from occiput to groin; which are less broken than most of those noted in *ovis*. Two other females have indistinct stripes from occiput to groin. Six of the seven also have dirty gray lateral stripes broken by spotting.

In general, specimens from other collections showed the same variation. Sixteen specimens from the Texas Wildlife collection from 15 mi. W. Zamora, Michoacán and several from other collections have strikingly marked venters with profuse light spots in strong contrast to the interstices. This contrast assumes even greater prominence due to the presence of extensive black pigmentation bordering light spots in 10 specimens. The number of light spots encircled by pigmented areas ranges from a few to many, with some having the bordering pigment broken, reduced to a semicircle, or limited to single dark macules. Dorsal surfaces usually dark, mottled with darker spots which occasionally form occiput-groin stripes. The *ovis* pattern is otherwise favored in that the sides are usually darker than the backs. In common with many toads from other localities, the dorsal surfaces are usually rough with a tendency toward microscopic pearly spicules on the pustules which are found in more or less abundance throughout the range. The feet are sparsely webbed.

It is our opinion that only one population is present on the plateau, represented by the color patterns attributed by Smith and Taylor to

oxyrrhinus and *ovis* and by intermediates. If the total color pattern for *ovis* or *oxyrrhinus* (as represented by Smith and Taylor) were arbitrarily used for identification, the intermediate pattern would predominate. If consideration of these arbitrary patterns is set aside, it is evident that individuals from a given locality may predominate in a single color component of one of the mosaics. In such instances, other components may vary from one extreme to the other or may trend toward another component in the other discarded color mosaics. Thus the individuals from 15 mi. W. Zamora tend to have lateral stripes darker than dorsal surfaces, as does *ovis,* but resemble *oxyrrhinus* in their general lack of occipito-inguinal stripes. In a majority of specimens from various localities, such components as *sides lighter than dorsal surfaces* with the reduction of light spots as is thought to be true of *oxyrrhinus,* are more frequently than not accompanied by the component of *occipito-inguinal stripes,* as described for *ovis.* In the absence of morphological differentiation other than variation in color and of consistent color combinations with a reduced number of intermediates, an explanation based upon two weakly differentiated species with extensive hybridization appears untenable. Any attempt to sort specimens into two species by an arbitrary combination of colors has failed. If these toads are regarded as a single species with each extreme in color combination treated as a variable component, it is evident that disjunction or discontinuous variation among the different components may occur, although continuous variation between the extremes of a single component such as *banded or not banded, lateral light spots or no lateral light spots, occipito-inguinal spots or no occipito-inguinal spots* usually occurs. The criterion of *dorsum darker or lighter than sides* usually depends upon the distinctness of lateral bands, but some with distinct lateral bands nevertheless have sides lighter than dorsum due to a variation in color of the lateral band from the usual brown or blackish brown to gray, not present in either dorsal or ventral surfaces. It is possible that the relative independence of the different components to each other may be explained on the basis of polychromatism resulting from previous secondarily isolated populations differentiating by the Sewall Wright effect before spreading back into their common range.

A large thoracic gland on the breast and upper abdomen of male *oxyrrhinus* as reported by Davis (1955: 71) is noted in both of the previously assumed species but is indistinct or absent in some adults and most juveniles.

Another curious color phase occurring rather erratically through the range is an overall ground color, which in alcohol is light gray, with black markings. In an individual from Ixtlán, Nayarit (FAS No. 8977 ♂), well-defined, narrow, undulating occipito-inguinal stripes are present with the triangular enclosed intervertebral area a trifle darker than dorsolateral surfaces. Thin, broken lateral stripes are present with subadjacent lateral surfaces being the same light gray as dorsolateral ground color without trace of light spots. Dorsal surfaces are smooth. FAS No. 8979 ♂ is similar with a light gray dorsal ground color and sharply defined occipito-inguinal stripes. Intervertebral area is no darker than dorsolateral surfaces and the sharp, black lateral stripe is continuous only on right side, terminating above the axilla on left; a dark chocolate, lateral band is present beneath and adjacent to black bands. The bands are

liberally sprinkled with contrasting light spots, as in *ovis*. FAS No. 8981 ♂, likewise from Ixtlán, has a darker gray dorsal surface, little evidence of black lateral bands, well-defined, light spotted brown lateral bands, but no trace of occipito-inguinal lines; dorsum rougher than the other two.

It is thus proposed that the two plateau color variants be taxonomically defined as a single population.

In 1883 Boulenger (344) proposed the name of *Hypopachus oxyrrhinus* for two specimens collected by Alphonso Forrer at the Presidio near Mazatlán, Sinaloa. Gunther (1900: 211) put *oxyrrhinus* in the synonymy of *variolosus*, and was followed by Kellogg (1932: 184). Parker (1934: 113) correctly restored it to specific status and was followed by Taylor (1940: 515). Descriptions of *oxyrrhinus* dating from Boulenger's are inadequate, either because of brevity or because they constitute a composite. Boulenger's cotypes were unavailable to the authors and it was felt that additional description of them (as would have undoubtedly been furnished by the British Museum) would be unsatisfactory inasmuch as species differentiation in *Hypopachus* is frequently based on minutae. Fortunately, a series of four well-preserved, nearly topotypical males were collected, three in the private collection of Charles H. Lowe (Nos. 7189-91, 8.8 mi. N. Mazatlán), and one in the collection of the University of Arizona (No. 106, 8.1 mi. N. Mazatlán). The most striking feature is wide lateral blackish bands strongly contrasting with brown to grayish-brown dorsal surfaces. These bands are developed as well as or better than any found in the plateau population. In two (UA No. 106 and CHL No. 7189), lighter spots are well developed in the lateral bands, whereas in others they are reduced or absent. Narrow, black occipito-inguinal stripes are well developed in one (CHL No. 7190) and rather poorly in another (CHL No. 7191). The ventral surfaces of these four are as strongly reticulated as those from the plateau, but light abdominal maculations are more irregular than in toads from the plateau. Spotting is more evident on ventral surfaces of hind legs. Light abdominal spots of plateau specimens are not necessarily circular, and in many only occasional maculations are round. Although toads from both plateau and Mazatlán coastal populations usually have largely discrete macualtions, one (CHL No. 7190) from Mazatlán has maculations which tend to be confluent. Feet of the four coastal specimens are more strongly webbed than those of plateau toads, the notch of the web between third and fourth toes extending to 1/3 distance or farther between proximal and second subarticular tubercles of fourth toe and at least half way between these two tubercles on third toe. Individuals from the plateau usually have a notch extending just distal to proximal tubercle on fourth toe, and occasionally the web is incised so deeply that the notch does not reach the tubercle. Of those few plateau specimens with the notch of the web about as extensive as in the coastal population, it usually extends less than half the distance between the involved tubercles on the third toe. Of 88 examined from the plateau, only five had webs equal to or exceeding the four from Mazatlán. Three of these five (UIMNH Nos. 31296, -98, -99) were males. Six more females examined from the same locality had reduced webs. Occasional individuals

from the plateau had webs which extended into incisions well between third and fourth metatarsals.

Another interesting morphological difference between coastal and plateau populations is the proportionally greater length of the hind foot in coastal toads. That of the four from the coast had a hind foot/snout-vent length ratio varying between 0.610 and 0.643 (av. 0.629), whereas that of 19 specimens from the plateau varied from 0.530 to 0.595 (av. 0.558), with a hind leg proportionately longer. A discussion of the hind foot of *H. ovis* from the topotypical plateau area adjacent to the coastal lowlands is found elsewhere.

Thus it appears that the name *oxyrrhinus* should be confined to the coastal population as represented at Mazatlán, leaving *ovis* as the valid name for the plateau population. The differences separating *ovis* from *oxyrrhinus* do not appear to be sufficient to grant the two populations specific status. It is proposed that the plateau population be named *Hypopachus oxyrrhinus ovis* with the type locality at Tepic, Nayarit, and the Sinaloan coastal population would be *Hypopachus oxyrrhinus oxyrrrhinus* with the type locality at the Presidio of Mazatlán. If *H. variolosus* should ever be demonstrated to be a subspecies of *oxyrrhinus*, the specific name of *variolosus* would replace *oxyrrhinus* as senior synonym.

On August 10, 1956, the authors collected a *Hypopachus* at the side of the paved road about three mi. E. San Blas, Nayarit. It was first noticed, about 8:30 P.M., by the amber glow of its eyes reflected in the car lights. The surrounding terrain was a swampy coastal marsh. Thirty minutes later the road temperature was 29.8° C.; the air, 26.4° C.; and 1 cm. above the road, 27.8° C. There had been heavy afternoon and evening showers three days previously, but only a few brief, scattered showers since. Between July 20 and 24 of 1957, we secured 19 more individuals in the low hills from 12 to 23.7 miles E. San Blas at an elevation of 250 to 700 feet, at night, during or just after heavy showers. The attempt to taxonomically allocate these *Hypopachus* led to an expansion in the scope of the present paper.

*Hypopachus oxyrrhinus taylori,** subsp. nov.

*Named for Dr. Edward H. Taylor in recognition of the considerable excellent work he has done in clarification of taxonomic problems in the genus *Hypopachus*.

Holotype. FAS No. 11309, male, collected by Frances L. Humphrey and Frederick A. Shannon on August 10, 1956, 3 mi. E. San Blas, Nayarit.

Paratypes. Eleven males and 8 females: FAS Nos. 12164-65, 12168, 12170, 12172, 12175, 12181; Univ. Ariz. No. 19723, Texas Coop. Wildlife Mus. No. 13003, UIMNH No. 41686; AMNH No. A-60669, all males, collected by F. L. Humphrey and F. A. Shannon from an altitude of 700 feet, 23.7 mi. E. San Blas; FAS Nos. 12171, 12173, 12176-77, 12180, and 12182 from 23.2-23.7 mi. E. San Blas, at 700 ft. elev., collected July 20, 1957, all females; FAS No. 12166 ♀ from 12-16 mi. E. San Blas, elev. 400 ft., July 23, 1957, and FAS No. 12167 ♀, from 16-20 mi. E. San Blas, elev. about 250 ft., July 24, 1957, all collected by F. L. Humphrey and F. A. Shannon.

Diagnosis. Most closely related to *H. o. oxyrrhinus* in the possession of large feet (foot/snout-length ratio varying between 0.575-0.655, av. 0.617 in 20 individuals of *taylori,* which is close to the 0.610-0.643 of the four individuals of *oxyrrhinus*); differing from *oxyrrhinus* in the presence of a minute, smooth, white (occasionally grayish) web between the third and fourth toes. *H. o. oxyrrhinus* has a large, pustular, black-edged web between the third and fourth toes. *H. o. ovis* has a small foot (ratio, 0.530 to 0.595, av. 0.558) and both *ovis* and *oxyrrhinus* lack the dorsal pinkish suffusion of *taylori.**

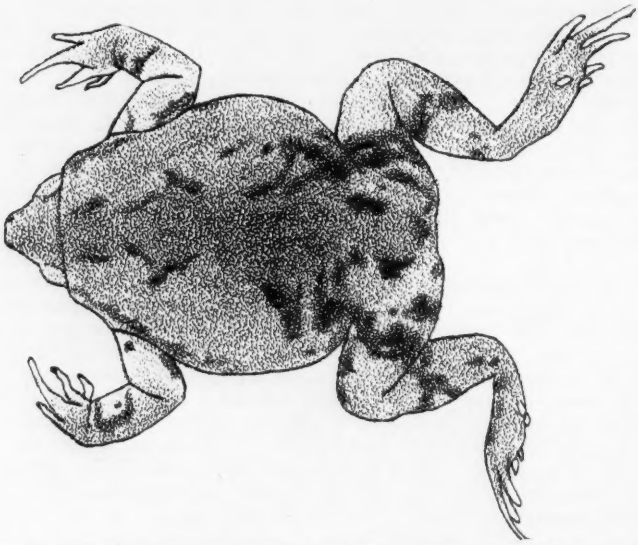

Fig. 1—Dorsal view of holotype of *Hypopachus oxyrrhinus taylori* subsp. nov., FAS No. 11309.

Description of the holotype. General physical shape similar to other two subspecies. Dorsal surface of head slightly convex, rather smooth with scattered small pearly spicules; supracranial fold distinct and in juxtaposition with posterior orbital border; canthus rostralis rounded, distinct; nares distinct, situated below canthus, directed superiorly and posteriorly; tympanum hidden; diameter of eye greater than distance between eye and snout and slightly less than interorbital interlude; pustular

*A few individuals of *taylori* collected by Langebartel and Schaffner from San Blas and preserved in formaldehyde lack a pinkish suffusion, but the dorsal surfaces are comparatively lighter than those from Mazatlán. The webs of these specimens also tend toward a grayish suffusion, apparently discolored by the formaldehyde, but the webs are small and nonpustular in contrast to those of Mazatlán individuals.

patch with pearls extending from above corner of mouth posteriorly and inferiorly to shoulder and separated from lateral extension of cranial fold by a deep sulcus; snout smooth, protruding considerably beyond mouth.

Tongue boletoid to elongate; vocal ostea ellipsoid, large, with black pigmented lining, located well lateral to posterior margin of tongue; choanae widely separated, partially hidden.

Dorsal surface of body profusely sprinkled with pale, pearled pustules; smaller pearls scattered over surface of arms and hands, legs and feet; U-shaped glandular ridge from above vent, curving and diverging anteriorly to a point above inguinal region, where it flares sharply, passing in front of inguinal region to dissipate on side of body. Vent slightly above mid-femoral line. Brachium short, partially buried in loose skin of body; transverse glandular fold on anterior brachial surface; antebrachium slightly bowed. Thenar tubercle large, elongate, flat; palmar tubercle smaller, elongate, flat, in contact with midpoint of anterior border of thenar tubercle; hypothenar tubercle smaller, widely separated from thenar and palmar tubercles; ventral surface of palm corrugated, vaguely pustular. Subarticular tubercles single, well developed, 1-1-2-2 in number, tubercle beneath terminal joint poorly developed or absent; digital formula, 3-4-2-1; second and fourth fingers subequal.

Heels broadly separated when femoral surfaces are adpressed to tibial surfaces; tarsal fold absent; median metatarsal tubercle large, raised, spadelike; lateral metatarsal tubercle, half or less than half as large as median tubercle and separated from it by a distance less than diameter of tubercle; median tubercle rounded, raised and likewise somewhat spadelike. Ventral surface of foot with small, scattered pearls; subarticular tubercles distinct, rounded, 1-1-2-3-2 in number; tubercles under metacarpo-phalangeal joints small on fourth and fifth digits, large on first. Webbing minute between all toes, most extensive between third and fourth, where notch of web extends to between the proximal subarticular tubercles of the respective toes; phalangeal formula, 4-3-5-2-1; toes with serrate, fringe-like extension of web on lateral surfaces extending to tips, fringe tending to be broken into distinct tubercles.

Border of lower jaw liberally sprinkled with pearls; gular area corrugate and pebbly; gular fold wrinkled, divided; two internal separated vocal sacs; glandular thickening on breast and anterior half of abdomen, evident but not well developed; posterior half of abdomen smooth with occasional scattered pearls; ventro-posterior femoral surfaces with flat pustules interspersed with scattered pearls.

Measurements of the holotype in millimeters. Snout-vent length, 42.0; head length, 9.8; head width, 11.5; diameter of eye, 4.2; eye-snout, 3.7; eye-nostril, 2.0; interorbital, 4.5; cranial fold-snout, 6.6; femur, 17.2; tibia, 17.4; foot, 25.5. Ratio of foot to body length, 0.610.

Color of holotype in alcohol. Ground color, pinkish-tan dorsally; darker over dorsum of snout; white band from below eye to behind and below corner of mouth; distinct, narrow, black, undulating occipito-inguinal stripes with intervening vertebral area slightly darker than ground color; narrow black stripe from nostril to eye and from eye to groin, occasionally broken at mid-body. U-shaped black mark on anterior surface of left antebrachium, broken into two transverse black bands on right; brachial

surfaces pinkish with black mark on dorso-posterior surface; a few black maculations over medial femoral areas with black transverse bands at mid-femur. These bands have small, central, irregular spots of the ground color; mid-tibial surfaces with two more or less confluent transverse black bands, with ground color intervening where the bands are separated; scattered black spots near tibio-tarsal junction.

Gular area dark bluish-black; belly reticulated as described in earlier discussion; reticulations continue on side almost to lateral black stripe and on femoral, tibial and dorsal metatarsal surfaces where they may be rounded. Ventral surfaces of toes, especially that of fourth toe, with wide, dark gray bands separated by subarticular tubercles.

Remarks. The pearls on the holotype of *taylori* are as well or better developed than in *Hypopachus alboventer reticulatus* and considerably more so than in the paratypic males. In contrast to the large, pustular, dark-edged third web of the Sinaloan males, the corresponding web in *taylori* is minute, smooth, cream-colored, with the notch barely reaching proximal tubercles on the third and fourth toes; hands and feet suffused with gray, whereas those of the Sinoloan toads are black. In alcohol the dorsum of *taylori* is a rich, pinkish-tan, whereas that of the four males of *oxyrrhinus* is a medium- to brownish-gray. The Sinaloan population has a wide, blackish lateral band; the black portion of this lateral band in *taylori* is less than half as wide, although an additional adjacent brownish area may make the total band somewhat wider. San Blas females have reticulated venters, with the whitish marks in about the same abundance as the gray interstices. There is little tendency for the light areas to form circles. The light ventral areas in *oxyrrhinus* are tannish rather than whitish, and the dark reticulations have a greater tendency to separate the light areas into discrete macules. This is also true of the males of *taylori,* although the light areas are whitish as in the females. In coastal forms from both Mazatlán and San Blas, there is less tendency for the light areas to form circular spots than in toads from the plateau. Some sexual dimorphism is present in the polytypic species, with a tendency for the light ventral areas to form circles in the males.

It is unfortunate that the type locality for *ovis* should be somewhat intermediate between the coastal and plateau populations. As would be expected in individuals from this locality, examples of *ovis* from Tepic, Ixtlán, and Ahuacuatlán are somewhat intermediate in their characters but more closely approach *oxyrrhinus.* Thus the feet of the Tepic population are webbed considerably more than *taylori,* or even *ovis* from Jalisco, but are webbed less than those of *oxyrrhinus.* The web of toads from the Tepic area, pigmented similarly to *oxyrrhinus,* not infrequently extends half or more of the distance from the proximal to middle tubercle on third toe and ¼ distance on fourth. The notching of these webs frequently extends as far back as the proximal intertubercular line; notching in *taylori* seldom extends as far distally. The feet of toads from Tepic and vicinity are intermediate in size between those from the coastal populations and those of *ovis* from Jalisco and Michoacán. The foot/body length ratio of 11 Tepic specimens varied between 0.495 to 0.620, av. 0.564. Ventral spotting on males from the type locality area of *ovis* is not greatly similar to that of either coastal population, and the tight, round, contrasting spots are more similar to those of males from Zamora, Michoacán.

The pinkish-tan dorsal ground color of *taylori* was not seen in any of the eighty-odd *ovis* examined from the plateau.

Two additional females are allocated to *H. o. taylori*. They have not been included as paratypes since a clear delineation of the range of *taylori* is not yet feasible and since presence or absence of characters typical of the holotype may be due to sexual dimorphism, introducing the possibility that they may not represent *taylori*. Females of the polytypic species *oxyrrhinus* largely appear to lack pearl formation.

The first of these females is Texas Wildlife No. 4697, 11 mi S. E. Santiago Ixcuintla, Nayarit, collected by James Dixon, at 50' elev. Santiago is about 30 miles north of San Blas on the Río Grande de Santiago. Unfortunately, the female represents one of the peculiar color variations similar to that noted earlier for *H. o. ovis*. Dorsum is light gray with an overwash of light yellow. Dark markings are brownish-black, distinct and fairly typical for any subspecies of *H. oxyrrhinus*. Occipito-inguinal stripes strongly developed, but broken. Contrasting paired transverse femoral and tibial bands present. Venter clearly but not strongly reticulated with light gray; still lighter marks are, on the whole, discrete, with more tendency to be rounded than usual in other coastal *oxyrrhinus* of the two subspecies. No females of *H. o. oxyrrhinus* are available, but the minute web of the present individual is probably beyond possibility of being due to sexual dimorphism. In fact, little web is evident except for a trace between fourth and fifth toes. The female, 32.8 mm. snout-vent length, has the large foot/body length ratio of 0.660.

Another female, CHL No. 7232A, from 1.8 mi. N. Rosa Morada, Nayarit, about 60 air miles north of San Blas and a little east of the swampy coastlands of Laguna de Agua Brava, has a scant web on the foot, smaller than the holotype of *taylori*. Dorsum medium gray-brown with blackish, broken, occipito-inguinal stripes; black, lateral stripes under-edged with wider, grayish stripe somewhat broken by lighter, indistinct spots; venter reticulate, although not strongly so, and the nature of the macules are close to those of the Santiago Ixcuintla individual. The Rosa Morada toad is large, snout-vent 42.4 mm. and foot/body length ratio 0.590. The toad is assigned to *taylori* on the basis of the small web.

We feel that any further taxonomic rearrangement in other Mexican populations of *Hypopachus* is unwarranted without careful study. Sibling species are common in Mexican amphibians, and the temptation to arrange large allopatric series in a polytypic species may result in increased taxonomic confusion as later studies reveal the true situation. *Hypopachus alboventer reticulatus* is disconcertingly similar to *Hypopachus oxyrrhinus taylori*, the two populations being easily differentiated only by the large webbing in *reticulatus*. On the other hand, *H. o. ovis* is similar to *H. caprimimus*, although foot size, web size and relative head size may serve to differentiate the two. Sympatry may exist between these latter two and between *caprimimus* and *alboventer*. The problem of whether *H. cuneus* is specifically or subspecifically related to *oxyrrhinus* cannot be settled by tempered logic in lieu of extensive field work.

The relationship of the ecology of the San Blas area to that around Mazatlán and of Guerrero is puzzling. The deciduous mesic jungles of

San Blas are strikingly different from the coastal thorn forest near Mazatlán. There appears to be little agreement between different biogeographers concerning the San Blas region. According to Smith (1949: 226), Mazatlán lies barely within the Sinaloan Province of his Sonoran Subregion, whereas San Blas is situated on the division between the Acapulcan and Fuerte Provinces of the Pacific Subregion. Peters (1955: 23) includes the area largely south of Mazatlán and through Guerrero in the Nayarit-Guerrero Biotic Province. He correctly states that the concept of the biotic province "should not be used as the basis for range definition of any form unless verified by accurate and adequate collecting information." No attempt has been made to do so here and such information is not necessary, as the *Hypopachus* involved are distinctly different, but it would be of general interest to have a better understanding of the isolating mechanism that has produced not only this new toad (*taylori*), but a new *Phrynohyas* (Shannon and Humphrey, 1957: 15) and a new *Cnemidophorus* (Lewis, 1956: 1).

Key to Mexican species of Hypopachus*

* Key adapted from Smith and Taylor (*op. cit.*: 94-95).

1. Width of head 3 times in snout-vent length (slightly more or less); sides of head and body dark brown, contrasting with dorsal color; ventral surface reticulated with brown enclosing cream spots; 50 mm. ..... *caprimimus.*
   Width of head in snout-vent length 3 to 4 times ..... 2.
2. Venter white or cream without distinct markings ..... 3.
   Venter reticulated with brown or black ..... 4.
3. Scattered black spots on sides and groin; spot on femur; a light stripe from eye to jaw angle; foot one-third to two-thirds webbed; 41 mm. ..... *maculatus.*
   No distinctive black spots on sides or groin; no light stripe from eye to jaw angle; foot less than one-third webbed; 44 mm. ..... *alboventer alboventer.*
4. Venter colored with reticulations of dark and cream, the cream not forming round light spots ..... 5.
   Venter reticulated with brown enclosing round light spots ..... 6.
5. Reticulation very light, often scarcely discernible; in some specimens a cream-colored, hair-like median line from snout to vent; a series of dark spots on dorsolateral line below which sides are lighter than back; 41 mm. ..... *cuneus cuneus.*
   Sides of head and body deep black reticulated with cream; groin and lumbar region spotted; venter very strongly reticulated with black and cream; 43 mm. ..... *cuneus nigroreticulatus.*
6. Dorsum heavily pustular in males, each pustule with a pearly spicule; thoracic gland in males extremely well developed with sharply outlined borders ..... *alboventer reticulatus.*
   Dorsum smooth or rugose and leathery, but pustules scattered or absent; pearly spicules of males usually less well developed; thoracic gland not well developed, indistinct, or absent ..... 7.
7. Foot almost free of web; pinkish dorsal coloration ..... *oxyrrhinus taylori.*

Foot usually 1/4 to 1/3 webbed; dorsum grayish brown, gray, or brown, but never pinkish ..... 8.

8. Hind foot/body length ratio 0.530—0.595 (av. 0.558) (Individuals in the Tepic-Ahuacuatlán-Ixtlán area, ratio—0.495—0.620; av. 0.564); found in plateau portions of Jalisco, Nayarit, Michoacán, and Colima ..... *oxyrrhinus ovis.*

Hind foot/body length ratio 0.610—0.643 (av. 0.629) found on coastal plain of Sinaloa near Mazatlán ..... *oxyrrhinus oxyrrhinus.*

We should like to thank Professors Hobart M. Smith, W. B. Davis, and Charles H. Lowe, Jr., for useful suggestions and for the loan of specimens, and to thank Mr. James Dixon and Mrs. Ellen C. Shannon for helpful suggestions.

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BOX 276, WICKENBURG, ARIZONA

A PREOCCUPIED NAME OF A NEOTROPICAL FROG, GENUS *ELEUTHERODACTYLUS.*—In 1875 (Journ. Acad. Nat. Sci. Philadelphia, 8: 107), Cope described *Phyllobates hylaeformis* from Pico Blanco, Costa Rica. In a recent paper (1952, Univ. Kansas Sci. Bull., 55: 689), Taylor placed Cope's species in the genus *Eleutherodactylus.*

In 1941 (Göteborgs Kungl. Vetenskaps Vitterheds-Samhäller Handlingar 6(B) L(4): 48), Melin described *Hylodes hylaeformis* from Roque, Peru. As both Melin's and Cope's species belong to the genus *Eleutherodactylus,* Melin's name appears preoccupied.

I propose the new name *melini* to substitute for the name *hylaeformis* Melin, 1941, preoccupied.—*Werner C. A. Bokermann, Rua Anita Garibaldi, no. 45, 51, S. 501, Sao Paulo, SP, Brasil.*

Life-history of the Western Spotted Frog in Yellowstone National Park*

By FREDERICK B. TURNER

Almost all discussions pertaining to the life-history of *Rana pretiosa* have been based on obscervations in British Columbia or the Pacific Northwest and except for the report of Tanner (1931) little has been made known for the eastern part of its range.

Observations of the western spotted frog were made in the vicinity of Fishing Bridge in Yellowstone National Park during the summers of 1953-56, on the north shore of Yellowstone Lake near the outlet of the Yellowstone River, at an elevation of about 7800 feet. This region has a mean annual temperature of 32.2° F. and a precipitation of 19.97 inches. The maximum temperature recorded over a 30-year period is 94°; the minimum -56°. The bulk of these observations were made at or near four pools about 1.5 miles west of Fishing Bridge:

Pool 1 forms in an open meadow from rain and melting snow during early May. It is about 60 by 45 feet and 16 inches deep. An aquatic plant, *Callitriche palustris,* grows at the surface of the pool during part of June. This pool exhibits fluctuations in temperature of as much as 24° in a day. As the summer advances it becomes smaller until it finally disappears in July.

Pool 2 is a spring in a marshy clearing in the pine forest. It is roughly elliptical, about 4 by 10 feet, and about 3 feet deep. A dense growth of *Spirogyra* clogs this spring.

Pool 3 is a subspherical pond which, like Pool 1, forms in May and is about 40 by 60 feet and a foot deep. Though located in an opening, lodgepole pines shade the eastern half of the pool. *Callitriche palustris* and an aquatic *Ranunculus* occur in it in late June and part of July but disappear later in the summer. Pool 3 exhibits a smaller range of variation in temperatures than Pool 1 and is, in comparison, cooler by day and slightly warmer at night. It persists longer during the summer than Pool 1 and evaporates some time during September.

Pool 4 forms from rain and melting snow during May and is 80 by 12 to 28 feet and about a foot deep. It is heavily shaded by lodgepole pines and supports little or no aquatic growth. It is colder than Pool 3 except in May when both pools are clogged with melting snow. It disappears in late August.

Emergence. The emergence of spotted frogs in the southern part of the Park is usually in May, but Yeager (1926) has reported their appearance at Old Faithful in April during an unusually warm period. Near Fishing Bridge, emergence is not before the first or second week in May. Apparently the entire population does not emerge simultaneously because, except for adult frogs which have moved to temporary pools for the purpose of breeding, few frogs may be found as early as May 21 except in a state of restricted activity in springs or permanent bodies of water, at the bottom of which they have hibernated. Activity during May

*Part of the author's doctoral dissertation, prepared under the direction of Robert C. Stebbins at the University of California.

and even early June is sporadic, with periods of quiescence induced by low temperatures when the frogs remain underwater for several days at a time. Emergence is gradual and some become active before others. Fluctuations in temperature may induce periods of dormancy in emerged individuals.

Aggregations at breeding sites. Temporary pools are usually utilized for breeding and males appreciably outnumber females in breeding aggregations. It also appears that males remain at the breeding sites longer than females, as in *Rana clamitans* (Martof, 1953). An analysis of the frequency of recapture in 1955 of males and females marked at breeding sites in 1954 and 1954 indicates that an appreciable proportion of males breed in 2 and sometimes 3 successive years, but there were no records of females breeding in 2 successive years. How often a female will lay is not known, possibly every third year or even less frequently. Blair (1943) showed that *Bufo americanus* females do not breed annually and Bragg (1940) came to the same conclusion with *B. woodhousei.* Considering the amount of energy invested in the egg complement the assumption that several seasons may be required for developmnt seems reasonable.

Oviposition sites. Occasionally springs are used for deposition. Pool 2 was so utilized in 1955 and one cluster was deposited there in 1954. Rarely, shallow streams or small puddles may be used. However, fairly large pools of stagnant water (e.g. Pools 1, 3) are usually used as deposition sites. All sites are only slightly shaded or completely exposed to sunlight.

Sometimes clusters are deposited in large pools, but fail to develop. On June 3 a small cluster was found at Pool 4 containing less than 80 eggs, almost all dead. On June 8 this mass was almost entirely disintegrated, containing 3 viable eggs. On June 11 a small mass containing 29 eggs was found at Pool 4. Twenty-one were dead, the others undeveloped.

Vocality. While breeding is in progress, males may call weakly from the edges of the ponds, usually at night but occasionally by day. The call is a series of bursts of 4 to 30 or more short croaks occurring at a rate of 3 or 4 per second with individual bursts separated by about 3 seconds. Calling is sporadic, several minutes elapsing between calls, or two or more males may call simultaneously. The call is so faint that if *Pseudacris* is calling at the same pond the calls of the spotted frog are nearly inaudible. When no *Pseudacris* were present I found the distance at which I could just hear the calls was about 80 feet. My findings with respect to the volume and quality of the calls are hard to reconcile with the report of Svihla (1935) regarding vocality of *Rana pretiosa* near Pullman, Washington.

Amplexus. Amplexus is axillary and may last for days. An amplexed pair collected on May 27 was kept in a jar for 6½ days, during which the embrace was never observed to be broken. On occasion males may grasp other males, in which case the embrace does not persist. Amplexus usually occurs in the water and during the period of embrace the male is carried about by the female without apparent influence on her movements. Occasionally an amplexus involving two males and one female may occur. One male grasps the female normally and the other male grips the

axillae of the female by reaching around the first so that his chin is appressed to the back of her head and his vent lies above the neck of the first male. On May 26 two of these trios were observed at Pool 1 and again on several later occasions.

Oviposition. Egg deposition starts in May and may continue into early June. At Pool 1 eggs first are laid in late May, at Pool 3 not until early June.

Freshly deposited eggs are from 10 to 12 mm. in diameter. The ova are black with a cream-colored spot at the vegetal pole and individual eggs of the same cluster are attached to one another by a gelatinous cord about 3 mm. in diameter. Svihla (1935) gives similar dimensions but describes each egg without connecting gelatinous cords. Egg clusters float freely in the water where the outer jelly layer acquires a coating of dirt and debris. Oviposition in a shallow concavity may tend to prevent scattering but winds tend to blow clusters about in larger pools. The clusters may range from 150 cc. to 500, with a mean of 300 to 350. The volume of an egg mass increases considerably owing to absorption of water and it is difficult to estimate the number of eggs in a cluster of a given size. Counts of eggs in clusters about 1 to 3 days old provided an index permitting the estimation of the number in a measured volume. A cluster of this age contained from about 1.0 to 1.4 eggs per cc. of volume (Table I).

TABLE I. RELATIONSHIP OF CLUSTER VOLUME AND NUMBER OF EGGS IN CLUSTERS

Locality	Date	Volume of egg mass (nearest 10 c.c.)	Number of eggs in mass	Eggs/c.c. of mass
Pool 2	May 23, 54	320	410	1.3
Puddle near Pool 1	June 12, 54	250	319	1.3
Stream 5 mi. N. Fishing Bridge	May 21, 55	280	802	2.8
Pool 1.5 mi. NE Fishing Bridge	May 26, 55	210	574	2.7
		670	629	0.9
		470	531	1.1
		500	612	1.2
		540	562	1.0
		450	769	1.7
		280	348	1.2
		250	341	1.4
		580	640	1.1
Pool 1	May 29, 55	300	206	0.7
Pool 2	May 29, 55	510	568	1.1
		480	635	1.3
Inlet Yellowstone Lake	June 3, 55	450	674	1.5
			Mean	1.4

The majority of eggs laid in one pond seems to be deposited in one place. This was best illustrated by about two dozen clusters found on May 26 in a rain pool about 1.5 miles northeast of Fishing Bridge. They were concentrated in an area 3 feet square although the pool was several hundred feet long by 50 to 60 wide. In general it appears that after egg deposition has been initiated by one pair of frogs, subsequent

oviposition by other pairs tends to be centered in or around the same place.

The 1955 reproductive effort was estimated at about 25,000 eggs which, even allowing for an error of 100 per cent, is low when one considers that a female bullfrog may lay as many as 20,000 eggs.

Development of eggs and larvae. During development of fertilized eggs some mortality occurs owing to low temperatures or exposure to air. The upper portion of a cluster is slightly exposed unless held under by other masses. These eggs, which may be encased in ice at times, usually do not develop.

The time required for the larvae to emerge is about 2 weeks, but may vary from 12 days to almost 3 weeks depending on local conditions. Hatching occurs over 10 to 12 days, reflecting differences in time of oviposition as well as in rate of development. The time at which all hatching had occurred varied from June 4 (Pool 1 in 1954) to as late as June 30 (Pool 3, 1955). The larvae at the time of hatching are about 10 mm. in length with the body slightly in excess of 3 mm. There are two pairs of tripartite gills and two prominent adhesive organs. Immediately after hatching the larvae are black. The anterior branch of each gill may contain 5 or 6 pinnate lobes, the medial branch 3 or 4 lobes, and the posterior branch is a stump.

A sample of 40 larvae (June 13, Pool 1) exhibited various stages in the resorption of gills, revealing that the right gills are resorbed first so that some larvae may have a single left gill in various stages of resorption. Usually by the time the right gill has disappeared the left is reduced to only one or two branches. The resorption of a gill proceeds in a posterior-anterior direction with the posterior stump disappearing first. At this stage (ca. 12 mm.) the uniform black pigmentation has been modified and the tail fin is mottled grey.

Four larvae (June 20, Pool 1) averaged 18.5 mm. long, the tail about 75 per cent. The dorsum is densely speckled with gold anteriorly, but sparser posteriorly. The adhesive organs are absent and 3 rows of labial teeth are visible (1/2). A sample of five larvae (June 30, Pool 1) averaged 29 mm. long with the tail about 66 per cent. The iris is flecked with gold; dorsum uniformly black, flecked with gold, denser laterally imparting an iridescent sheen to the flanks; venter iridescent bronze; chin weakly pigmented by guanophores; tail fin and musculature weakly pigmented with spots of melanin. A second row of upper labial teeth may be present, represented only by short lateral portions.

Larvae collected July 7 from Pool 1 showed only an increase in length (32-39 mm.) and the development of a third row of lower labial teeth. The definitive pattern of labial teeth seems to be 2 upper rows (one of which is represented by short lateral portions) and 3 lower rows (2/3). Two variations of this arrangement were observed: the absence of the incomplete upper row (1/3) and the existence of only 2 lower rows (2/2).

Hind legs appear 40 or 50 days later, reaching a maximum extended length of about 25 mm. by the time of transformation. Subsequent development involves an increase in size to as much as 60 mm., with the tail about 66 per cent. About 60 days after hatching a decrease in total length begins which continues until metamorphosis.

The left front leg appears first, after about 60 to 70 days, and there is a 3-legged stage, which must be very brief judging from the small proportion (ca. 2 per cent) collected in mass samples. After the appearance of the right front leg there is a period of perhaps 10 to 15 days while the tail becomes shorter and the transforming tadpole spends more and more time basking at the edge of the pool. After transformation the young may remain briefly in the vicinity, but soon disperse. Newly transformed frogs were found only in the immediate vicinity of the pools from which they had just emerged.

On September 6, one day before Pool 3 dried, the entire remaining larval population was collected. Of the 493 examined, 403 had only two legs (or none), 8 had three legs, 80 had 4 legs, and 2 were fully transformed. Since no eggs hatched in this pool after June 30, it is evident that more than two months would be required for the bulk of the larvae to transform. No doubt some had left the drying pool by the time that the sample was taken. It appears that transformation occurs from late August until mid-September, by which time the temporary ponds have evaporated. When eggs are laid in permanent water like Pool 2, failure to transform by the end of summer is not fatal. Advanced larvae were taken from Pool 2 in June indicating that some may transform in their second summer. According to Logier (1932) *Rana pretiosa* tadpoles probably overwinter regularly in interior British Columbia.

Hibernation. No frogs were found in hibernacula, but the situations in which hibernation occurs could be inferred. In the vicinity of springs there are a number of holes, filled with water from underground sources. Some of these pits, 2 or 3 feet in diameter, are 4 or 5 feet deep. The water is renewed slowly from below, but there is frequently so much debris in the water that the holes are nearly concealed. In September the population of these holes increases and frogs apparently move to them from some distance. In May, after many frogs have travelled to breeding ponds, there are large numbers around these pits but as summer progresses the number dwindles. Hibernation must also occur in springs and along creeks. In general a situation in which water is constantly renewed and never frozen solid would fulfill the requirements.

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Postglacial Dispersal of the Turtle *Chrysemys picta*

By SHERMAN BLEAKNEY

It is an accepted fact that North America was recently subjected to several successive glaciations. When one considers what a profound influence these glacial and interglacial periods must have had upon populations through scattering and confining them, creating and eliminating gene pools, forcing migrations vertically and horizontally, it seems almost presumptuous to attempt to classify organisms in their "true" relationships. It is almost impossible to fit living organisms whose relationships are as variable and changing as the environments which produce them into the neat static categories of the Linnaean system. The ever-increasing list of terms describing newly recognized relationships, such as cline, rassenkreis, formenkreis, sibling species, ecotype, character displacement and polymorphic species, emphasizes how different are the histories of various species even within the same area. Schmidt (1938) applied the postglacial history approach to distributional problems in amphibians and reptiles with success. Since that time there has been an increase in the number of taxonomic papers in North America which have attempted to explain the present relationships of organisms through a consideration of their probable postglacial dispersal. Smith (1957) has presented an excellent analysis of the influence of postglacial climatic changes on the dispersal and distribution of species and subspecies of many eastern amphibians, reptiles and mammals.

The North American turtle *Chrysemys picta* presents a case wherein the postglacial dispersal approach may be applied with advantage in attempting to interpret the relationship of its four forms. These were analyzed by Bishop and Schmidt (1931) who recognized four subspecies with broad areas of intergradation. Taxonomically, they used the classical approach of the family tree and named the most intermediate in character of the four (*marginata*) as the parent form. The interesting picture emerging from their study is the arrangement of the 4 subspecies in three major geographic groups: (1) *C. p. picta* in the Atlantic Coastal region, (2) *C. p. marginata* and *C. p. dorsalis* in the lower Great Lakes, Ohio River basin and lower Mississippi River basin, and (3) *C. p. belli* on the great plains. It seems peculiar that the Plains and Atlantic forms should occupy such large areas (Fig. 1), but show no appreciable variation, whereas in the single river system of the Ohio and lower Mississippi there should be two forms as distinct as *marginata* and *dorsalis*. The present relationship of these two subspecies is not clinal, thus raising the problem of how they maintained their identity while confined together in the lower Mississippi valley during glaciation, especially if *marginata* is considered to be of such antiquity that it gave rise to the other three forms. The difficulties can be resolved if *marginata* is considered as a recently developed intra-specific hybrid of *belli* and *dorsalis*. This is not unreasonable if the following hypothetical sequence of events can be accepted.

At some period in the evolution of *Chrysemys* it was divided into an Atlantic coastal form with parallel dorsal laminae and a form west of the Appalachian Mountains with alternately arranged laminae. Presumably

the species was rather plastic in size and color pattern. During the Wisconsin glacial period various populations became isolated south of the ice sheet. Judging from present distribution according to Adams (1902), Brown (1904) and Smith (1957), it would seem that three isolated populations survived: one in a refugium near New Mexico, another in the Louisiana area and the third on the southern Atlantic coastal plain. During this long period of isolation, local conditions and normal gene drift may have added to and emphasized the original minor differences of these populations. When the glaciers began their latest retreat, the genus *Chrysmys* can be pictured as composed of three disjunct and therefore reproductively isolated populations. At that time they might well have been designated as *C. picta* of the southeast Atlantic coast, *C. dorsalis* of the lower Mississippi and *C. belli* in the southwest.

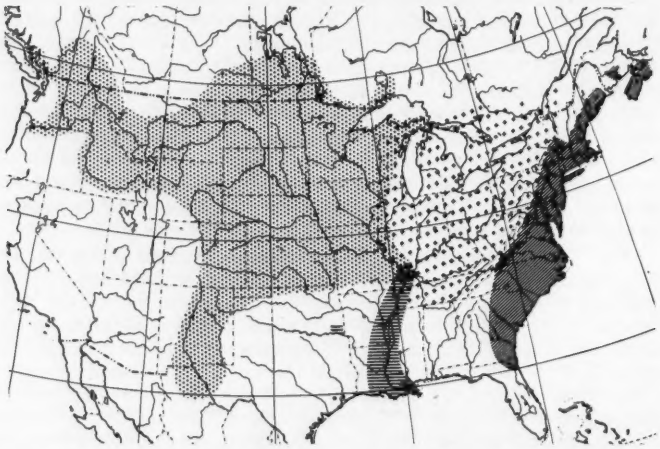

Fig. 1. The present range of the four subspecies of *Chrysemys picta:* Stippling, *belli;* crosses, *marginata;* horizontal lines, *dorsalis;* diagonal lines, *picta.* Compiled from Carr (1952), Stebbins (1954), Logier (1955), and personal field work in Alberta and eastern Canada.

The retreat of the continental glaciers was accompanied by a northward dispersal of the three forms of *Chrysemys.* The plains form, *belli,* fanned out north and thence west through southern Idaho into Oregon, Washington and British Columbia. To the east it followed the Missouri River system and contacted *dorsalis* which had dispersed up the Mississippi River. The area of contact, I suggest, was near the Missouri-Mississippi-Ohio junctures. The result of this contact was the creation of a population intermediate in character, that is, a normal intergrade population at the contact zone of two formerly disjunct forms. The unique aspect of this situation, as reference to Fig. 1 shows, is that the hybrid population is *in front* of the two parent populations, not *between* them, and the entire uncolonized Ohio River and lower Great Lakes drainage

lies before it. With the new intra-specific hybrid population being infused with *belli* genes from the west and *dorsalis* genes from the south, and granting some heterosis, it then would be reasonable to expect it to spread to the northeast and occupy the area where no *Chrysemys* had yet arrived, the form *picta* being barred from the area by the Appalachian Mountains. This would create the present day distribution pattern of Chrysemys with *marginata* answering for the *belli* x *dorsalis* hybrid form. Table 1 lists the chief intermediate characters of *marginata* when compared with *belli* and *dorsalis*.

As a check on the above hypothesis, specimens of *marginata* from eastern Ontario, far from areas of intergradation, were examined for evidence of genetic throwback to *belli* or *dorsalis*. It was found that some had a much reduced plastral pigment pattern and a few lacked it. This has been noted by Agassiz (1857) and Bishop and Schmidt (1931), and could be attributed to *dorsalis* gene influence. The plastral pattern varies greatly and three specimens of 69 examined, tend toward *belli*. One from Hamilton, Ontario, has a very large plastral figure intermediate between typical *belli* and *marginata*. In another, from near Ottawa, the figure has extensions out along the seams as in *belli*. The third from Port Dover, Ontario, on Lake Erie, has a typical *belli* plastral figure and a few light reticulations on the carapace.

Table 1. Diagnostic characters of the three races of *Chrysemys picta* which possess alternately arranged dorsal laminae. Note intermediate nature of *marginata*.

belli	*marginata*	*dorsalis*
	Length	
max. 9.84″ av. 8″	max. 7.41″ av. 6″	max. 5.91″ av. 5″
	Middorsal stripe	
inconspicuous or absent	narrow	broad
	Plastral figure	
dark, covers most of plastron	covers ½ of plastron	none
	Light anterior borders of laminae	
none	rare	extensive

None of the Ontario material shows evidence of *picta* influence such as aligned dorsal laminae, but *picta* from New England often possess the structural and pigmentary characters of *marginata*. Bishop and Schmidt (1931) confined the intergrade area of *marginata* and *picta* to southeastern New York. However, as far back as 1899, Allen mentioned that a few specimens of *picta* which he had seen from eastern Massachusetts had dorsal laminae arranged alternately as in *marginata*. Babcock (1933) extended the known range of these intergrades to the east coast in Massachusetts and north to Norway, Maine. Actually, *marginata* influence extends to the northeastern limits of the range of *picta* for I have found intermediate specimens in New Brunswick and Nova Scotia. In a series of 31 *picta* from Nova Scotia and New Brunswick, 12 have a dark plastral figure towards the rear of the plastron and on seven it extends anteriorly to near the pectoral laminae; three have the dorsal laminae arranged alternately, resembling typical *marginata*. It may be that *picta* is exception-

ally plastic, but since this degree of variation is limited to the northern portion of its range it suggests another explanation. From the evidence of Bishop and Schmidt (1931) *marginata* occupied southern New York State (via Mohawk Valley) prior to *picta.* However, the intermediate specimens from the New England coast and in Maritime Canada suggest that *marginata* may have reached the Atlantic coast in New England about the same time or before *picta.* Possibly the intergrade population of *marginata* x *picta* thus formed continued dispersing up the coast, which would explain the intermediate nature of the turtles which colonized the Atlantic coastal region north of the Hudson River Valley area of contact.

If this hypothesis is accepted, the relationship of *marginata* to the other three forms of *Chrysemys* is hybridization rather than classical bifurcation or schistic evolution (as of Simpson). If the isolated Wisconsin period populations are designated as A for *belli,* B for *dorsalis* and C for *picta,* then *marginata* can be represented by A + B and the northeastern *picta* population by (A + B) + C.

This is not surprising, but should be expected in Holarctic fresh water organisms since Hubbs (1955) stressed the high incidence of natural hybridization in North American freshwater fishes and attributed this in part to the vast shifts in Pleistocene climate and associated faunal disruptions.

Huntington (1952) found that populations of the two grackle subspecies *Quiscalis quiscula stonei* and *Q. q. ridgwayi* were actually vigorous hybrids of the western *Q. q. versicolor* and the eastern *Q. q. quiscala.* These two parent forms apparently had been isolated in Texas and Florida during glaciation, and upon contact during postglacial dispersal developed a successful hybrid population. Similar cases of recent hybridization should be sought in North American amphibians and reptiles, especally in genera and species which are widespread and consequently may have dispersed from several glacial refugia. Such genera as *Pseudacris, Bufo, Pseudemys, Crotalus, Thamnophis, Pituophis* and *Elaphe* might profitably be considered from this viewpoint.

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BRAIN CHORIOID PLEXUSES OF A DIPNOAN—The lateral and fourth ventricle plexuses of amphibians differ greatly from the reptiles in their form and variation. This is especially true of the tailed amphibians. Among the elasmobranchs and ganoid fishes there are some similarities in these structures but in the dipnoan *Protopterus,* there are a number of marked likenesses. This is not surprising when we realize how many other amphibian resemblances there are to lunged salamanders among these interesting lung fishes. Because of this it is easy to understand some theories of the past that have linked air-breathing fish types with the semi-aquatic group of frogs, toads and salamanders. The following description of these brain structures in *Protopterus,* gives another type of resemblances to the salamanders not described before.

The specimen studied was 360 mm. long with a brain length of 20 mm., of which the cerebral region was 10 mm.

The superficial plexus of the thalamus and mid-brain region is well supplied with large blood vessels. (Fig. 1, from above. Fig. 2, the same structures removed and viewed from below). On the inner side of this membrane with heavy blood vessels, at the caudal end and either side of the midline, is a convoluted membrane much like that found in elasmobranchs (Hilton, 1954, Bull. So. Calif. Ac. Sc., 63:107-113). These appear as plexuses penetrating the lateral cerebral cavities, but in this dipnoan they are much smaller than those of sharks and rays. These are the only lateral plexuses of the brain cavities of elasmobranchs. This is not true of *Protopterus,* where in addition, each lateral cavity of the cerebral hemispheres has a broad, thin chorioid plexus which resembles that of many salamanders. A lateral view of the plexus on the left side is shown in figure 3, with its network of blood vessels. Each of these lateral bodies is narrowly united at the midline to the one of the other side in its caudal region through the foramen of Munro.

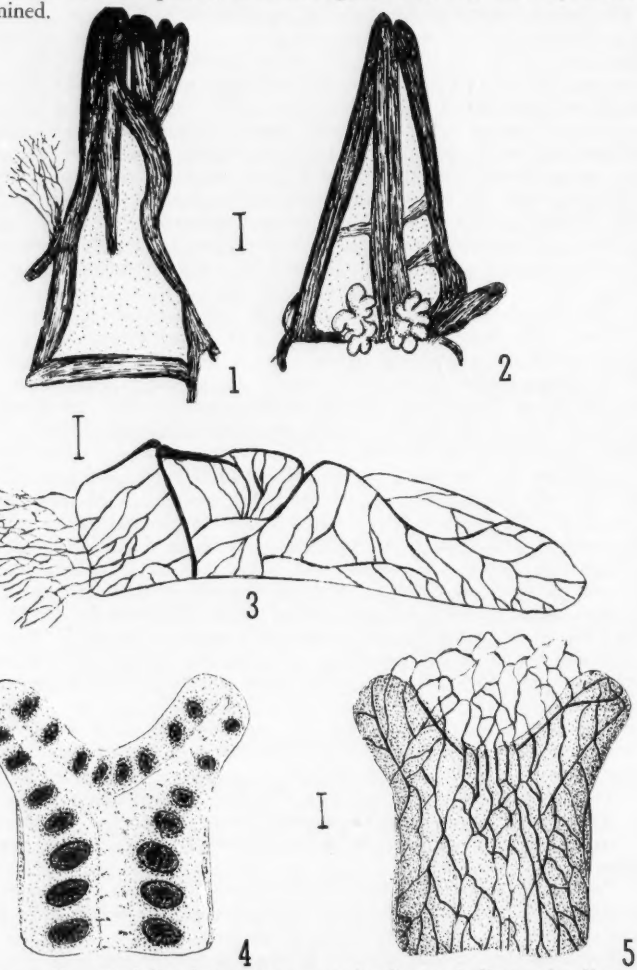
In the region of the fourth ventricle the chorioid plexus is a thick, well-developed dorsal vascular plate which is deeply pitted underneath. This is shown from below in figure 4, and above in figure 5.

This fourth ventricle roof appears much like the same structure in some sharks and ganoid fishes but much more like that in a number of amphibians.

The important points in the brain plexuses of this dipnoan are:

1. A heavy plexus of large blood vessels near and in the roof of the region of the third ventricle. A condition a little like that of some teleost fishes.
2. Two small plexuses penetrate the brain cavity from the third ventricle plexus. These are similar to more marked structures which extend a short distance into the lateral cavities of sharks and rays.
3. There are thin vertical, vascular plexuses in the cerebral hemispheres, one in each hemisphere. They are connected across the middle line, being very much like the lateral plexuses of tailed amphibians. In fact they are more like the structures of salamanders than any other vertebrates.
4. The thick, vascular roof of the fourth ventricle is pitted underneath like that of some elasmobranchs and amphibians but is more like the latter.
5. From a study of other brains, such as ganoids and teleosts, (in press),

the fourth ventricle plate is like some ganoids but not like any teleost examined.



The small vertical line between or near the figures indicates the distance of 1 mm. in every case. All figures are from *Protopterus*.

Fig. 1. Upper view of the plexus over the third ventricle.

Fig. 2. Inner view of the last.

Fig. 3. Side view of the right lateral plexus of the cerebrum with the cephalic end at the right.

Fig. 4. Inner view of the roof of the fourth ventricle.

Fig. 5. Upper view of the last.—*W. A. Hilton, Pomona College, Calif.*

A New Species of Pit Mite (*Acarina: Ophioptidae*) Infesting Snakes

By DORALD M. ALLRED

The genus *Ophioptes* Sambon 1928 includes five described species of mites which inhabit pits in the scales of Colubrid snakes. Each of the species has been described from only one or a few available specimens. Through the courtesy of Chapman Grant of Escondido, California, it was my good fortune to receive two infested grass snakes from Cuba. One was collected by Mr. Grant at Banes, Oriente Province in April, 1956 (Grant, 1957). The second was collected by Lt. j. g. Andrew Asielman, U. S. Navy, at Guantanamo, Oriente Province in March, 1958. From these snakes I removed 49 female, 35 male, 9 nymphal and 12 larval pit mites. The mites taken from the snake from Banes are herein described as a new species. Inasmuch as only larval and nymphal mites were taken from the snake from Guantanamo, it is not possible to determine their specific status at this time.

Ophioptes dromicus sp. nov.

Female. Length, including the gnathosoma, 350 microns; width at the widest part of the body exclusive of the legs, 355 microns.

The dorsal surface of the propodosoma is provided with eight pairs of setae arranged in two lateral groups (fig. 1); the posterior seven pairs are 21-31 microns in length, and the anterior pair is 13 microns. There are four pairs of setae 6-7 microns in length near the center of the metapodosoma.

The ventral part of the propodosoma is provided with two pairs of peg-like setae 14 microns in length, each with several ridges or leaves (fig. 2). There is a pair of setae 16 microns in length immediately anterior to the first pair of pegs. There are four pairs of setae 10-16 microns in length distantly surrounding the anus (fig. 2). The anal opening is near the posterior end of the idiosoma. Four pairs of very minute setae are situated immediately adjacent to the anal opening (fig. 3).

The ventral part of the gnathosoma (fig. 4) is provided with a pair of centrally located, hypostomal setae 19 microns in length. On the postero-lateral edge of each palp (the femur) is a modified seta 6 microns in length and somewhat blade-shaped. On the antero-lateral edge of each palp (the tibia) is a thick, modified seta 12 microns in length. There is a similar seta 18 microns in length on the dorsal side of the palp (tibia). Ventrally on each palp (tibia) there is a claw with two large prongs. Opposite the base of each claw (on the tarsus) are two medial setae,—a basal one 11 microns in length and a distal one 17 microns. Each palp terminates in a foot-like seta consisting of one large and three smaller prongs. The chelicerae are simple, long needle-like stylets.

Leg I. The coxa and trochanter each has one short seta. The femur has one whip-like seta and one thick seta, both of medium length. The genu has two short setae and one long whip-like setae. The tibia has a thick, spur-like, serrated seta 17 microns in length, one short seta and one thick seta of medium length. The tarsus has an annulated peg seven microns in length, one long whip-like seta, two thick seta of medium

length, two short single-barbed setae and four other short setae. The tarsus ends in a cup-shaped sucker and a double-forked seta with long, external serrations (fig. 5).

Leg II. The setation of the coxa, trochanter, genu, tibia and tarsus is similar to leg I. The femur has only one whip-like seta.

Leg III. The coxa has one short seta. The trochanter has one short seta and one long seta. The femur has a whip-like seta. The genu has a short seta. The tibia has a spur (as on tibia I and II) and a long, thick seta. The tarsus lacks a peg, but has two whip-like setae of medium length, two short single-barbed setae and four other short setae. The sucker and double-forked seta are present.

Leg IV. The coxa, femur and genu lack setae. The setation of the trochanter, tibia and tarsus is similar to leg III.

Male. Length, including the gnathosoma, 325 microns; width at the widest part of the body exclusive of the legs, 300 microns.

The dorsal part of the propodosoma has eight pairs of setae arranged in two lateral groups (fig. 6). The posterior seven pairs are 20-26 microns in length; the anterior pair are 7 and 10 microns. Situated between these two groups of setae is the genital opening. Close to and partly surrounding the genital opening are four pairs of setae. The anterior three pairs are 8 microns in length; the posterior pair is 15 microns. Anteriorly and centrally situated on the metapodosoma are two pairs of minute setae 6 microns in length.

The ventral part of the propodosoma is provided with two pairs of peg-like setae, each about 12 microns in length but more slender than in the female. The ridges on the pegs are not as pronounced as those on the pegs of the female. There is a pair of setae 14 microns in length immediately anterior to the first pair of pegs. There are two pairs of setae 10 microns in length on the ventral part of the metapodosoma. The anus apparently is lacking.

The setal pattern of the gnathosoma is similar to that on the female except for some setae on the palps which are of the following lengths: lateral tibial setae, 14 microns; dorsal tibial setae, 15 microns; basal median tarsal setae, 13 microns; distal median tarsal setae, 18 microns. The tibial claws, foot-like tarsal setae and chelicerae are similar to those on the female.

Leg I. The setation of the coxa, trochanter, femur, genu and tibia is similar to that on the female. The tarsus has an annulated peg as on the female, two setae of medium length and seven shorter setae. The sucker and double-forked seta are similar to the female.

Leg II. The setation on the coxa, trochanter, femur, genu and tibia is similar to that on the female. The tarsus has an annulated peg, two setae of medium length and six other short setae.

Legs III and IV. The setation of all of the segments are similar to those on the female.

Nymph. Each of the nine specimens collected was still enclosed within the larval integument. They were so lightly chitinized and folded that an accurate description was not possible.

Larva. General shape bag-like with the broadest part posterior. Legs are lacking. Length, including the gnathosoma, 550 microns; width, 490 microns. The dorso-lateral surface of the idiosoma has three pairs of setae

12 microns in length. These are arranged in an irregular anterior to posterior line on the posterior third of the body. The anal opening is situated near the posterior end of the body on the ventral surface. Immediately posterior to the anus are five pairs of setae; the four posterior pairs are 8-10 microns in length, and the anterior pair is 6 microns. There are no other setae on the idiosoma. The gnathosoma is very simple and in the specimens at hand lacks setae except for the palpal tarsus. Each tarsus terminates in a minute, blunt spur. There is a similar spur on the ventral side of the tarsus below the terminal spur. The chelicerae are similar to those of the adult.

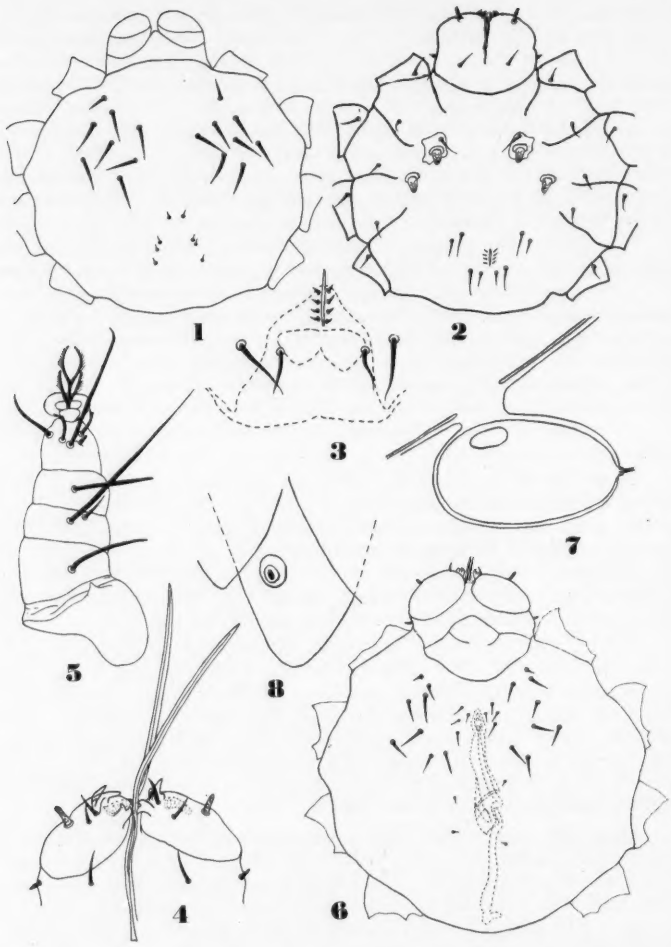
Type Data. The holotype female was taken from a pit in a dorsal scale of the grass snake, *Dromicus andreae orientalis* (Barbour and Ramsden). The snake was collected by Chapman Grant at Banes, Oriente Province, Cuba in April, 1956. The allotype male and 8 female, 14 male, 1 nymphal and 3 larval paratypes were taken from the same host as the holotype. The holotype, allotype and some paratypes are in the collection of the author. Other paratypes will be deposited in the collections of the British Museum of Natural History, United States National Museum, Dr. C. D. Radford, Dr. R. V. Southcott and the University of Maryland Institute of Acarology.

Discussion of O. dromicus. There are relatively few differences between specimens herein designated as male and female except for the genital and anal openings and their associated setae. In *O. dromicus* the genital opening of the male is situated anteriorly on the dorsal surface of the idiosoma. In the female the genital opening apparently is in common with the anus or the anus is lacking, for no other opening was observed. No opening is present in the typical anal area of the male.

The lengths of the setae and their locations are very similar on both sexes. In most cases the variation between them does not exceed that which occurs between different individuals of the same sex. However, the following differences between the sexes apparently are constant. The anterior pair of dorsal propodosomal setae of the male is slightly shorter than on the female. The ventral pegs of the male are more slender, and there are only two pairs of dorsal metapodosomal setae on the male. The males usually are smaller in size than the females.

Apparently mites of this species are somewhat host specific, for not a single mite was found on more than 60 specimens of *Alsophis* taken from the same areas as *Dromicus*. The pits in which the mites were found are oval, each with a circular opening approximately 200 microns in diameter (figs. 7, 8). Each pit angles downward anteriorly and was almost completely filled by a single mite. The majority of the pits on the snake from Banes were situated in the first and second rows of the dorso-lateral scales. Only a very few pits occurred in the ventral scales and these were located laterally. On the snake from Guantanamo, most of the pits occurred on the chin and throat. Few mites were found in the dorsal scales. Most of the infested scales had only one pit, although as many as four pits were found. The pits usually were situated near the distal ends of the scales; some were found under overlapping scales.

Examination of the mites indicates that the mite develops to the adult stage while within the larval integument in the pit. I prefer to call the



Pl. 1. *Ophioptes dromicus*. Fig. 1, dorsal view of female; Fig. 2, ventral view of female; Fig. 3, genito-anal opening of female showing internal structure; Fig. 4, ventral view of female gnathosoma; Fig. 5, dorsal view of leg I of female; Fig. 6, dorsal view of male showing internal penal apparatus; Fig. 7, lateral view of pit in scale of snake; Fig. 8, opening to pit in scale.

legless, bag-like immature mite the larva rather than the nymph or puparium as designated by previous workers. I believe that the nymph does not exist as a separate and distinct stage, but is only a very temporary and intermediate stage during a continual developmental period from larva to adult.

Some of the adult mites which were collected intact within the larval integument were oriented upwards toward the opening of the pit at an angle of 90 to 180 degrees from the position of the larval gnathosoma. This placed the adult in position to rupture the larval integument at a point close to the opening of the pit. It seems likely that the modified, toothed setae and claws of the palps are used to obtain release from the larval integument.

Affinities of the Species. —I am indebted to the following men and institutions for the loan of the cotype and paratype materials as follows: Dr. G. Owen Evans, British Museum of Natural History, male cotype of *Ophioptes oudemansi* Sambon; Dr. E. W. Baker, United States National Museum, female cotype of *O. tropicalis* Ewing; Dr. C. D. Radford, female paratype of *O. coluber* Radford; Dr. R. V. Southcott, two female paratypes of *O. samboni* Southcott. The other described species, *O. parkeri* Sambon, is represented only by the holotype male in the British Museum.

From the descriptions given in the literature and the examination of specimens on loan, I concur that *O. oudemansi* and *O. parkeri* were described from male specimens. Other known species of the genus have been described from female specimens. In as much as the cotype of *O. oudemansi* is so poorly cleared that most characters are not distinguishable and *O. parkeri* was not available for study, it is impossible at this time to compare the males of the two above species with the male of *O. dromicus*.

Comparison of the females of *O. coluber, O. samboni, O. tropicalis* and *O. dromicus* show some interesting differences and similarities. The two latter species are slightly smaller than *coluber* and *samboni*. The length of the anterior-most pair of dorsal propodosomal setae on *tropicalis* and *dromicus* is less than 14 microns, whereas on *coluber* and *samboni* the setae are more than 30 microns. There are no great differences between the lengths of the other dorsal setae, although those on *coluber* and *samboni* generally are longer than those on the other two species. Apparently there are four pairs of dorsal metapodosomal setae on all four species. Southcott (1956) stated that *samboni* possesses only two pairs, but examination of both paratypes shows four. These setae on *dromicus* are 6-7 microns in length, whereas on the other three species the setae vary from 11-21 microns. On *tropicalis* and *dromicus* there are four pairs of minute setae immediately adjacent to the anal opening. On *coluber* there aparently are only two pairs, whereas on *samboni* they are lacking. On *tropicalis* and *dromicus* the postero-lateral setae of the palps are less than 9 microns in length, whereas on *coluber* and *samboni* they are more than 46 microns.

The general setation of legs I and II is similar on all four species. Southcott stated that femur II of *samboni* possesses two setae. Examination of the two paratypes shows only one, which is the condition on the other three species. On *coluber* and *samboni* femur III is nude, whereas on *tropicalis* and *dromicus* there is a whip-like seta present. Genu III of

coluber, samboni and *tropicalis* is nude, but on *dromicus* there is a short seta present.

On the basis of the previous discussion, it is obvious that *coluber* is most closely related to *samboni,* and *tropicalis* to *dromicus.*

Sambon (1928) described the caruncle on *oudemansi* as two hollow, divergent pads. This is the general appearance on the cotype of *oudemansi.* However, I believe that possibly due to the shrinking action of the media and the poorly cleared and mounted specimen, Sambon may have misinterpreted the shape of the caruncle. There also is some doubt as to the presence of the three pairs of lateral dorsal spines above legs II-IV (I-I?I according to Radford, 1947) on *parkeri.* The ventral locations of the coxal setae on other species are identical with Sambon's or Radford's descriptions of the dorso-lateral spines in relationship to the legs. The coxal setae may have been misinterpreted as being situated dorsally as well as ventrally.

In view of the above discussion, the following key to the female mites of the genus *Ophioptes* of the world is presented.

1. Postero-lateral setae of the palps blade-like, less than 10 microns in length; anterior pair of dorsal propodosomal setae less than 15 microns in length 2

   Postero-lateral setae of the palps normal, gradually tapering, more than 40 microns in length; anterior pair of dorsal propodosomal setae more than 30 microns in length 3

2. Genu III with a short seta . . . *O. dromicus* (known only from *Dromicus andreae orientalis* (Bar. and Ram.) from Oriente, Cuba).

   Genu III nude . . . *O. tropicalis* (known only from *Erpetodryas carinatus* (L.) from British Guiana, South America).

3. Two pairs of minute setae immediately adjacent to the anal opening; postero-lateral setae of the palps more than 60 microns in length . . . *O. coluber* (known only from *Elaphe radiatus* (Sch.) from Manipur, India).

   Anal setae lacking; postero-lateral setae of the palps less than 50 microns in length . . . *O. samboni* (known only from *Rhynchoelaps fasciolatus* (Gun.) from North Queensland, Australia).

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Reproduction, Young, Eggs and Food of Oklahoma Snakes

By CHARLES C. CARPENTER

The following notes have been assembled from observations made chiefly at the University of Oklahoma Biological Station, Marshall County. They refer to twenty-two species and subspecies collected, for the most part, in the southern regions of the state. Most observations were made in terraria in the vertebrate laboratory during the summers of 1952 through 1957.

All measurements are recorded in centimeters. Because of the frequency of injury to the tails, the body length is used for a more exact comparative criterion. Thus, all snake lengths are recorded as "body length/total length." In a few records only total length is given.

The term "regurgitation" as used for food records, refers to forced regurgitation of the living snake.

Natrix erythrogaster transversa. A female bore seventeen young in late August. Another (79/101.3) contained sixteen embryos on July 28. One had eaten a small fish. A male was forced to regurgitate a one-inch and a six-inch fish. A female regurgitated a crayfish.

Natrix r. rhombifera. A female (82/103.3) contained seventeen embryos on July 28. A series, taken in July, had gorged on carp trapped in a drying backwater of a tributary of the Red River. Another regurgitated a large *Rana pipiens.* A large female had eaten a six-inch *Lepomis sp.*

Natrix sipedon confluens. A female (44.8/56.9) regurgitated five recently transformed *Hyla cinerea.*

Storeria dekayi. A female (18.3/22.3) contained eight embryos, July 26. Another (23.6/29.6) bore twelve young August 7. Five males, 7.8/10.4 to 8.2/10.9, av. 7.96/10.6. Five females, 6.9/9.1 to 8.4/10.7, av. 7.84/10.1. Another bore nine young on August 12. Four males, 7.8/10.5 to 8.2/10.9, av. 7.95/10.67. Five females, 7.7/9.8 to 8.9/11.3, av. 8.18/10.36. A female was forced to regurgitate a slug. Two hibernating adults were uncovered on January 3, eighteen inches deep in a damp jam of drift compacted of bark, logs, sticks, sand and mud. The snakes were wet and very sluggish and had cloacal temperatures of 8° and 11.8° C. An adult *Rana pipiens* was hibernating in the same jam.

Thamnophis sauritus proximus. A gravid female (67) contained fifteen embryos (near term) on July 22. A female (53.4/74.9) bore nine young September 14. Three males, 19.5/28 to 20.8/29.2, av. 19.4/27.6. Another female (57.3/79.3) bore twelve young inside a collecting sack between 4:30 and 8:00 p.m. Five males, 19.2/27.3 to 22.5/31.4, av. 20.6/29.1. Seven females, 19.9/27.7 to 20.4/28.5, av. 20.1/27.8. Another (46/64.3) bore four young, August 25. All males, 16.5/22.8 to 17.4/25, av. 17.0/23.6. Another (63.5/87.7) contained fourteen embryos on April 29. Another (62.1/70.2) bore ten young August 16. Seven males, two females and one undetermined. Males, 15.6/21.4 to 16.0/22.4, av. 15.9/22. Females, 14.8/20.6 to 15.6/21.4, av. 15.2/21. Another (78.5/99.1) bore eighteen young July 18 between 9:00 and 10:00 p.m. In two instances two young in separate membranes

emerged simultaneously. The young broke from their membranous sacs in from five to thirty seconds. Two males, 17.1/23.9 to 20.2/28.3, av. 19.5/27.3. Eight females, 19.3/26.6 to 19.5/27.6, av. 19.5/27.1. Males from 1.6 to 2.3 grams, av. 2.19. Females, 1.9 to 2.3 grams, av. 2.16.

Thamnophis sirtalis parietalis. A female (66.5/86.7) bore twenty-eight young July 28 before 7:30 a.m. The young, in coiled positions in membranous sacs, appeared to exert pressure on the sides of the sacs. Movements of the female dragged a sac, it broke and the young snake became active immediately. The young began to shed a very thin membrane as soon as they dried. All twenty-eight were born successfully except one which was not fully developed. Fourteen males, thirteen females, and one undetermined. Males, 12.5/16.9 to 17.6/23.9, av. 17.4/22.5. Females, 15.9/21.2 to 17.4/22.7, av. 17.1/22.0. The positions of the umbilical scars (beginning with the anal and passing anteriorly) 13th ventral (1), 14th (3), 15th (10), 16th (8), 17th (2), 18th (2), 22nd (1). The scar varied from one to four ventrals long and was frequently preceded and followed by a fold or crease of five to ten ventrals. Another (81.0/91.2) DOR, June 24, contained eleven embryos and four additional yolks.

Haldea striatula. A female (21.9/25.15) bore six young August 6, between 10:00 p.m. of the 5th and 8:00 a.m. of the 6th. One had died in its sac. Males, 7.7/9.8 and 7.8/9.9 av. 7.75/9.85. Two females, 6.6/8.1 (dead) and 8.2/9.5, av. 7.6/9.2. A female (21.1/26.4) contained three embryos on June 9. A female (21.9/25.7) bore six young during the night of June 20. Four males 7.6/9.7 to 8.8/11.1, av. 8.25/-10.28. Two females, 8.9/10.5 to 9.1/10.95, av. 9.0/10.7.

Heterodon p. platyrhinos. A female (55.8/66.3) laid five eggs (3—August 16, 2—August 17), av. 3.86 x 1.8.

Coluber constrictor flaviventris. A female (88/116.9) laid eleven eggs July 16 over a period of five hours. Eggs av. 3.5 x 2.0. A large female regurgitated an *Opheodrys aestivus.* Another regurgitated a grasshopper and a camel cricket.

Masticophis f. flagellum. A female (118.7/141.4) laid twelve eggs July 7, between midnight and 6:45 a.m. One egg was premature and smaller and had been laid on the day previous. Av. 4.39 x 2.63. Another (124/160.2) laid seven eggs on July 17. Av. 4.11 x 2.46. Another (116.9/148.8) laid thirteen eggs July 2, during the morning. Av. 3.58 x 2.16. A large male regurgitated two *Cnemidophorus sexlineatus* and a *Sceloporus undulatus.* Another male had a *Cnemidophorus sexlineatus* in its mouth when caught. A large female regurgitated three newly hatched *Cnemidophorus sexlineatus.* A small female regurgitated three lizard eggs. A large female regurgitated a newly hatched *Sceloporus undulatus* and the remains of three adult *Cnemidophorus sexlineatus.* A small male regurgitated three *Lygosoma laterale.* A large gravid female regurgitated a nestling Eastern Cowbird. An adult contained two large grasshoppers and two last instar cicada nymphs.

Masticophis flagellum testaceous. A juvenile regurgitated two newly hatched *Cnemidophorus sexlineatus.*

Opheodrys aestivus. A female (68) laid six eggs July 6. Av. 2.77 x 1.16. Another (44.1/66.2) DOR contained seven eggs. Another

(43.5/63.5) laid three eggs July 31 before 9:15 a.m. Av. 3.66 x 0.99. A large female regurgitated a medium sized grasshopper.

Elaphe guttata emoryi. A small specimen regurgitated an adult *Sceloporus undulatus.*

Elaphe o. obsoleta. A female (125.5/149) contained nine embryos on June 6. A large specimen was found in hibernation October 18 along the flood plain of the South Canadian River, Cleveland County. It was in a cavity in the base of a rotting stump, buried about eight inches down in the rotten wood. It moved slightly, in a circling coil, when exposed. A juvenile regurgitated an adult *Sceloporus undulatus.* A large female contained a small domestic turkey. A large female regurgitated two adult *Cnemidophorus sexlineatus* and part of the tail of another. A gravid female regurgitated two eggs of a guinea fowl.

Pituophis catenifer sayi. A female (117/129.5) laid eight eggs July 1. Av. 5.52 x 3.0.

Lampropeltis c. calligaster. A female (96/110.5) laid fourteen eggs July 20. Av. 2.43 x 1.65. Another (108.5/118.3) laid fourteen eggs July 1, in four hours. Av. 3.93 x 2.37.

Lampropeltis getulus holbrooki. A female (94.1/105.3) laid sixteen eggs June 28, in six hours. Av. 2.98 x 2.03.

Sonora e. episcopa. A female laid three eggs June 17. Av. 2.35 x 0.54. Another laid one egg June 19, three more June 22, and one more June 23. Av. 1.99 x 0.64. A large male regurgitated a medium-sized scorpion. Another regurgitated two coleopterous larvae and a moth.

Tantilla g. gracilis. A female (17.3) laid three eggs June 18. Av. 2.1 x 0.48. Another (18/20.7) laid two eggs July 1; eggs very elongate with a transverse constriction in the center. Av. 2.46 x 0.53. A small male regurgitated a small caterpillar. A large female regurgitated two coleopterous larvae. Another regurgitated three coleopterous larvae. Another regurgitated two coleopterous larvae.

Ancistrodon contortrix. A female bore four young August 17. When noticed at 12:30 p.m., all the young were in sacs with only the head or the nose protruding. At 4:30 p.m. a mild prodding did not induce them to rupture from the sacs. By 8:00 a.m. of the following day they had all emerged. Three males, 22.5/26.4, 22.2/26.3, and 23.3/27.2. Female, 21.7/25.4. Another (56.1/64.3) contained four embryos June 18. Another (56/65) contained one embryo in July. Another (53.5/61) contained four embryos July 18. Another bore six young August 16. A large male regurgitated two cicadas and one spider.

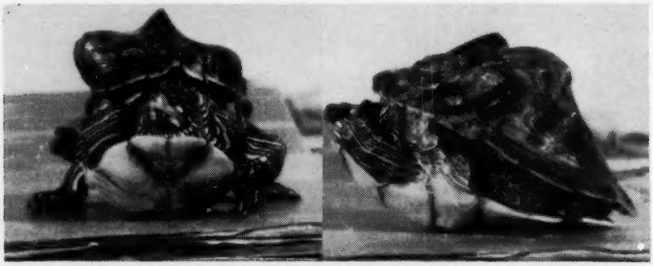
Ancistrodon piscivorous leucostoma. A female (39/44.3) contained four embryos July 17. One regurgitated a juvenile wood thrush. Another regurgitated seven last instar cicadas. Another regurgitated a young cottontail (*Sylvilagus floridanus*).

Crotalus atrox. A female bore four young August 15 during the night. One was abnormal, being contorted by adhesions along the sides of the body. Normal male, 34/36.7 (37.5 to tip of button). Two females, 33.4/35.7/36.5, and 31.8/33.9/34.7.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF OKLAHOMA, NORMAN

AN UNUSUAL OUACHITA MAP TURTLE—On July 26, 1957, a very unusual adult specimen of the Ouachita Map Turtle (*Graptemys pseudogeographica ouachitensis*) was brought to the University of Oklahoma Biological Station by the local game warden. He had received it from a woman who had caught it on a hook while fishing in Caney Creek, southeast of Kingston and near Lake Texoma in Marshall County.

The gross appearance of this turtle is that of an extremely distorted carapace and highly convex plastron, so arranged as to leave the normal soft parts very exposed (see Figs.). Species and race identification were easily made since the color markings were normal. The carapace length was 11.6 cm., the width at the bridge 6.5, the plastron length 11.2, and the depth of the shell at the bridge 8.1.



The carapace is abnormally high, the keel rising to a very sharp ridge, particularly in the center of its longitudinal axis. The costal scutes of the anterior half of the carapace are very distorted. The first two anterior costals on the right extend knob-like in a laterally-directed process. This is matched by a shorter but similar lump on the left side. Also present in this region are smaller gnarls. The portion of the carapace anterior to the bridge is also shortened exposing the retracted head of the turtle. The posterior portion of the carapace approaches normal shape for this species. There are no supernumerary or lacking scutes and all are well defined by sutures. In the region of the bridge, which is abnormally high, the carapace is greatly constricted laterally, being equal to or slightly less in width than the plastron.

The plastron is normal in length and scute pattern, but its shape is extremely distended or bowed in a convex manner, particularly in the anterior half, and because of the shorting of the anterior part of the carapace, extends anteriorly somewhat beyond it. The bowing effect or convexity is marked for both the longitudinal and transverse axes.

Inside this unusual shell, the body appears to be normal, but exhibits an ungainly appearance when the appendages and head are extended. The short carapace offers little protection for the front legs and head. Because of the convex plastron, the legs must be extended to their full length to reach the substrate and offer support. The bulky shape of the shell makes swimming and particularly maneuvering very difficult..

These distortions of the shell are thus primarily associated with the anterior portions of the carapace and the plastron. In spite of this grotesque shell, the turtle appears to be very healthy.—*Charles C. Carpenter, Department of Zoology, University of Oklahoma, Norman.*

Notes on the Maxillary Dentition of Some Hylid Frogs

By COLEMAN J. GOIN

While working on some South American frogs of the genus *Sphoenohyla* (Goin, 1957 Caldasia, 3:11-31.) I had occasion to examine the maxillary dentition in some other Hylidae as well. The original purpose of gathering these data was to determine whether a reduced number of maxillary teeth was characteristic of the genus *Sphoenohyla,* as stated by Lutz and Lutz (1938 Ann. Acad. Brasileira Sci., 10:175-193, figs. 1-7.). These data not only demonstrate that some species of this genus have reduced maxillary dentition, *S. habra* in fact apparently being toothless, but also present some interesting information on tooth counts on other forms within the family and reveal some problems that other students may be able to pursue. Therefore, since I have had to put aside the project of counting maxillary teeth, I believe it advisable to make such data as I now have available.

I am indebted to the Graduate School of the University of Florida for making the services of an assistant available to me for the purpose of the study and I am particularly indebted to the assistant, Mr. Arthur J. Getzkin, for his dilligence and care in removing the maxillae of frogs and making the necessary tooth counts. Dr. William Riemer, curator of the University of Florida herpetological collections, and Dr. M. Graham Netting and Mr. Neil D. Richmond of Carnegie Museum generously let me use specimens in their care for the purposes of this study. Dr. W. Frank Blair of the University of Texas and Drs. W. B. Davis and Richard Baldauf of Texas A. and M. College not only loaned me specimens of *Pseudacris clarki* in their care but made special efforts to obtain additional specimens from critical localities. My colleague, Dr. Walter Auffenberg, prepared the sketch of the maxillary teeth of *Pseudacris clarki* for me. To all of these I owe my thanks.

To count the teeth acurately, it is necessary to remove the maxillary bone. This is done by first separating the fleshy skin from the left upper jaw by simply running a needle along under the lip. With fine pointed scissors the quadratojugal is then cut posterior to the maxillary bone and a similar cut is made on the premaxillary bone anterior to the maxilla. With forceps and scissors the maxillary bone can then be worked loose and cut from its articulations with the pterygoid, palatine and nasal bones and removed from the head. The mouth can then be closed and will show no signs of mutilation. Since the right side of the skull and posterior portion of the suspensorium of the left side are left intact, this removal of the maxillary will not interfere with making subsequent head measurements.

After the jaw bone is excised it may be washed in a weak solution of Sodium Hypochlorite (Clorox or a similar commercial bleach used full strength is satisfactory) to remove any excess flesh, rinsed in clear water, then soaked for several hours to as much as overnight in a second washing of clear water. It is then ready to dry and examine. We found that the amount of time necessary to soak the bone free of all trace of the bleach solution depended on the size of the bone. Small bones such as

those in *Pseudacris* wash clear in an hour or two whereas jaw bones from the larger species such as *Hyla maxima* and *Phyllomedusa bicolor* make better specimens if soaked overnight.

In *Pseudacris clarki* a dimorphic dentition was noted that seems to have escaped observation. Among seven specimens examined, from Brazos County, Texas, three had the maxillary teeth much larger and fewer than seems typical for the species (see fig. 1). In search of further individuals with this remarkable dentition I wrote Dr. Blair at Austin and Dr. Davis at College Station for the loan of further comparative material. They both generously forwarded specimens and consequently counts are available on 260 individuals from a number of localities in Texas, Oklahoma and Kansas. As may be seen from the table, excluding the three specimens with the large teeth, the 238 males had the teeth on the maxillary range from 33-52 with an average of 41.69 whereas the 19 females range 38-50, average 44.16. The three individuals with reduced dentition have the following numbers of teeth on the left maxilla: UF 550-3 (9); UF 552 (11); UF 6656 (12). Two specimens are females, the last a male.

I suspect that this peculiar type of dentition is correlated with sexual maturity. UF 550-3 and UF 6656 are both definitely immature. Their sex had to be determined by dissection since neither was in breeding condition. They have snout-vent lengths of 21.0 and 15.3 mm. UF 552 on the other hand has a snout-vent length of 29.3 mm. and appears adult. Dissection reveals pigmented eggs in the ovary which has not yet ruptured so there are no free eggs in the body cavity as might be expected with a female taken in amplexus.

In each of the three noted, the premaxillary teeth were similar in size and structure to those on the maxilla.

In addition to the three specimens from Brazos County, Texas, with the large teeth, specimens of *P. clarki* with normal dentition have been examined from the following counties: KANSAS—Harper; OKLAHOMA—Bryan; TEXAS—Bastrop, Brazos, Burnett, Caldwell, Comal, Dawson, Eastland, Erath, Gillipsie, Gonzales, Harris, Hays, Hutchinson, McLennan, Palo Pinto, Refugio, San Patricio, Travis, Victoria, Wharton and Williamson.

In addition to the findings concerning dimorphism of the teeth in *P. clarki*, other points seem worthy of attention.

Only in *P. clarki* were enough specimens of both sexes examined to determine whether there was evidence of sexual dimorphism. This is definitely indicated with 238 males having an average of 41.69 teeth on the maxilla whereas 19 females average 44.16. This same situation might be expected in most species where the female exceeds the male in size. In general it seems that big frogs tend to have more teeth than small frogs.

The largest frogs do not always have the most teeth as is strikingly indicated in the genus Acris, where *A. g. blanchardi*, the largest form, has the fewest teeth, average 27.78, *A. g. crepitans*, a form intermediate in size has an intermediate number, average 32.11, and *A. g. dorsalis*, the smallest form, has the greatest number, average 39.18.

In several cases where specimens of the same nominal form were available from distant localities, these are listed separately simply to indicate the extent of geographic variation in tooth counts. Such variation

does exist since it is shown by the fact that in two of the four cases where specimens of the same nominal species were available from Trinidad and Leticia, Amazonas, Colombia, there was not even any overlap in the counts of maxillary teeth.

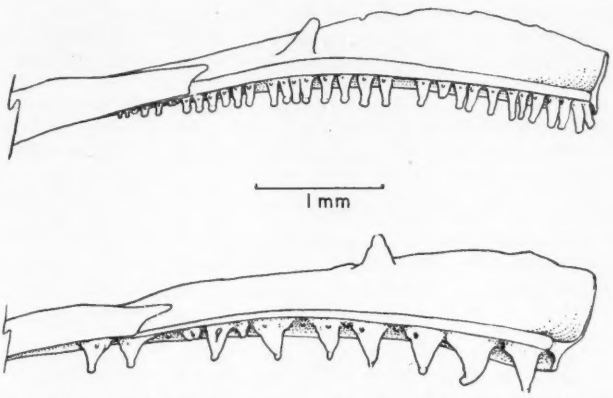


Fig. 1. Upper. Left maxilla from *P. clarki* UF 3787, from College Station, Brazos Co., Texas. Lower. Left maxilla from *P. clarki* UF 552, from one mile west of College Station, Brazos Co., Texas.

In the following table the first column of figures refers to the number of specimens, the second gives the range in tooth count, the third the average number teeth on the maxillae and the fourth the standard deviation.

Acris gryllus blanchardi, Texas: Brazos Co. ..	9	23-32	27.78	3.00
Acris g. crepitans, New York: Orange Co.	9	28-35	32.11	3.76
Acris g. dorsalis, Florida: Baker and Hendry Co.	22	35-47	39.18	7.28
Agalychnis dacnicolor, Mexico: Nayarit	1	51	51	
Agalychnis helenae, Costa Rica	1	79	79	
Gastrotheca oviferum, Venezuela	6	57-68	63.00	3.51
Hyla andersoni, New Jersey: Ocean Co.	9	41-53	45.11	3.33
Hyla arborea japonica, Korea	10	33-41	37.30	2.60
Hyla arenicola, Arizona: Cochise & Pima Co.	13	24-54	36.54	7.55
Hyla baudini, Mexico: San Luis Potosi	4	57-64	59.75	3.10
Hyla c. cinerea, Florida: Alachua Co.	4	59-63	60.75	1.71
Hyla crucifer, Alabama, Florida, S. Carolina ..	14	29-41	34.57	3.74
Hyla eximia, Mexico: Morelos	10	35-41	37.60	2.37
Hyla femoralis, Florida: Alachua, Volusia, Lake Polk and Marion Co.	18	49-65	55.28	4.23
Hyla goughi, Trinidad	2	43-47	45.00	2.83
Hyla gratiosa, Florida: various localities	16	44-61	54.75	4.97
Hyla lanciformis, Colombia: Amazonas (Leticia)	10	79-105	89.40	7.69

Hyla laynei, Colombia: Amazonas (Leticia)	2	52-55	53.50	2.12
Hyla leucophyllata, Colombia: Amazonas (Leticia)	6	40-65	50.67	9.69
Hyla maxima, Trinidad	3	90-101	96.00	5.56
Hyla maxima, Colombia: Amazonas (Leticia)	4	104-128	115.25	9.85
Hyla minuta, Trinidad	4	49-52	50.00	1.42
Hyla nr. *misera*, Colombia: Amazonas (Leticia)	9	42-50	46.11	2.62
Hyla ocularis, Florida: Alachua Co.	14	28-44	38.21	4.99
Hyla phaeocrypta, Florida: Jackson Co.	10	28-53	43.90	4.77
Hyla phaeota, Panama Canal Zone: Barro Colorado Island	5	58-72	65.80	6.18
Hyla phaeota, Costa Rica	2	62-74	68.00	8.49
Hyla punctata, Colombia: Amazonas (Leticia)	9	59-68	64.57	4.69
Hyla punctata, Trinidad	8	65-73	68.50	3.07
Hyla punctatissima, Trinidad	3	72-73	72.33	0.61
Hyla regilla, California: Alameda Co.	8	39-46	42.38	2.72
Hyla rubra, Colombia: Amazonas (Leticia)	10	69-80	75.40	6.79
Hyla rubra, Trinidad	4	67-72	69.50	2.08
Hyla sarayacuensis, Colombia: Amazonas (Leticia)	8	47-61	55.75	5.34
Hyla septentrionalis, Bahama Islands and Florida: Monroe Co.	7	51-62	57.00	4.47
Hyla squirella, Florida and Georgia	13	55-66	59.15	4.06
Hyla versicolor, Texas: Brazos Co.	4	47-57	51.75	4.12
Phrynohyas zonata, Colombia: Amazonas (Leticia)	4	66-78	73.75	5.32
Phrynohyas zonata, Trinidad	3	51-56	54.00	2.65
Phyllomedusa bicolor, Colombia: Amazonas (Leticia)	1	80	80	
Phyllomedusa burmeisteri, Trinidad	3	72-88	80.00	8.00
Pseudacris brachyphona, Alabama: Tuscaloosa Co.	5	40-49	45.00	3.39
Pseudacris brachyphona, West Virginia: Nicholas Co.	10	37-48	42.20	4.21
Pseudacris brimleyi, South Carolina: Jasper Co.	1	46	46	
Pseudacris clarki, males (see text)	238	33-52	41.69	3.76
Pseudacris clarki, females (see text)	19	38-50	44.16	3.37
Pseudacris nigrita feriarum, Alabama: Tuscaloosa Co.	8	42-50	45.00	3.21
Pseudacris n. feriarum, Virginia: New Kent Co.	10	36-46	42.00	3.63
Pseudacris n. kalmi, New Jersey: Bergen Co.	5	34-37	36.20	2.61
Pseudacris n. triseriata, Texas: Brazos Co.	3	41-50	44.67	4.73
Pseudacris n. verrucosa, Florida: Alachua and Hillsborough Co.	4	40-51	46.00	4.69
Pseudacris ornata, Florida: Alachua Co.	10	38-45	41.10	2.13

Pseudacris streckeri, Texas: Bexar Co.	1	32	32	
Sphoenohyla aurantiaca, Colombia: Amazonas (Leticia)	2	30-33	31.50	2.12
Sphoenohyla habra, Colombia: Amazonas (Leticia)	2	0	0	
Sphoenohyla nana, Bolivia and S. Brazil	5	32-48	37.20	6.57

DEPARTMENT OF BIOLOGY, UNIVERSITY OF FLORIDA, GAINESVILLE, AND RESEARCH ASSOCIATE, CARNEGIE MUSEUM, PITTSBURGH

THE SNAKE *HALDEA VALERIAE PULCHRA* IN MARYLAND.—In 1948 the writer reported *Haldea valeriae* Baird and Girard (NHSM-R1065) from Swallow Falls Park, Garrett Co., Md. (Md. Nat., 18: 51-52). This was the first record of *Haldea* from the Alleghany Plateau of Maryland. In 1954, Richmond (Ann. Carn. Mus., 33: 251-260) described *Haldea v. pulchra* from Pennsylvania, saying of the above Maryland specimen, ". . . it is presumably *pulchra.*" The range he gave as ". . . apparently restricted to the unglaciated Alleghany High Plateaus and Alleghany Mountain section of the Appalachian Plateau Province from New York to West Virginia." Data recently acquired greatly augment those previously known for this subspecies in Maryland. All specimens mentioned are in the Natural History Society of Maryland (NHSM).

Range in Maryland. Apparently restricted to the Alleghany Plateau and recorded to date only from Swallow Falls Park and vicinity, Garrett Co. A specimen of *Haldea* (NHSM-R1640) from Big Pool, Washington Co. (on the eastern edge of the Alleghany Ridges of the Appalachian Province), the closest area to the Alleghany Plateau from which we have *Haldea,* is *H. v. valeriae,* as are all from the rest of the state, and shows no visible evidence of intergradation.

Description in life of a Maryland specimen. (Fig .1). A gravid female (NHSM-R1678) taken August 3, 1957, at "moss fields," Swallow Falls Park, shed its skin the day after capture. Appearance glossy; scales keeled dorsally, keels fainter laterally and disappearing on the first and possibly second scale rows; color russet-tan, suffused with pinkish-orange towards ventrals; russet-orange mid-dorsal stripe from back of parietals to end of tail; dorsal stripe bordered with black flecking; lateral black spots spaced, but arranged almost linearly at level of 4th row; occasional black spots elsewhere; supralabials pale, dusky, not as light as infralabials and chin; head and neck flecked with black; approximate center third of venter yellow, grading on sides into pinkish-orange, becoming white at 9th scute; chin white, flecked sparsely with gray; top and rear of eye with continuous russet half-moon; scale rows 16 (just behind head)-15-

17-17; supra- and infralabials 6-6; postoculars 2R-3L; ventrals 121; caudals 32.

Size and sexual dimorphism. Largest adult female, 275 mm. total length; smallest, 10 day old female, 110 mm. total. Data for 3 males and 3 females, respectively: ventrals 121, 120, 116, 122, 121, 123; caudals 43, 41, 42, 35, 32, 31; ventrals minus caudals 78, 79, 74, 87, 89, 92; total length 115, 119, 113, 110, 275, 230; tail length 23, 21, 22, 17, 44, 35; percent tail of total length 20.0, 17.6, 19.5, 15.5, 16.0, 15.2.

Breeding. The four shortest specimens listed above were born Aug. 25, 1957, to the largest female listed, taken Aug. 3. Richmond (*op. cit.:* 256) found only 2 males in each of four litters, numbering 5, 5, 7 and 8 young. The above litter contained 3 males, 1 female. The level of umbilical attachment varied between ventrals 13-18. Within 2 to 3 days after birth the young shed their natal skin.

Habitat and associations. Swallow Falls Park and its environs are at about 2500 feet elevation and are characterized by mixed deciduous and hemlock. Most of the specimens were taken under rocks (except one DOR) in timbered areas with dense undergrowth of ferns and bryophytes, or in a bog where ferns, sphagnum, and other mosses predominated.

Remarks. Haldea v. pulchra in Maryland averages a higher number of caudals in both sexes than *H. v. valeriae;* the number apparently varies by as much as 10 to 12 scales.

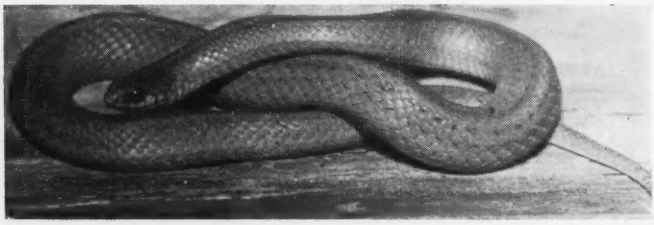


Fig. 1. Adult female *Haldea valeriae pulchra* Richmond (NHSM-R1680) from near Swallow Falls Park, Garrett County, Maryland; photo by Dr. Robert S. Simmons.

The specimen of *Haldea* from "moss fields" mentioned by Lemay and Marsiglia (1952, Copeia, 3: 193) cannot be located. It is undoubtedly *pulchra.* A male *pulchra* (NHSM-R1641) catalogued as from "Pennsylvania" has no other collection data; scales 15-17-17; supra- and infralabials 6-6; 233 mm. total, 47 tail (20% of total length); 116 ventrals, 45 caudals, ventrals-minus-caudals 71; dark dorsally, dark color encroaching onto edge of ventrals, contrasting with light venter. This is, according to Richmond (*op. cit.:* 253), characteristic of specimens from the northern Pennsylvania counties.—*John E. Cooper, Dept. Herpetology, Nat. Hist. Soc. Maryland, and Baltimore City College, Baltimore, Maryland.*

ANURAN RECORDS FROM THE UPPER COASTAL PLAIN OF WESTERN AND CENTRAL GEORGIA.—Wright and Wright (1949, Handbook of Frogs and Toads) report the Ornate Chorus Frog, *Pseudacris ornata* (Holbrook) occuring from the Carolinas to coastal Georgia and Florida and along the Gulf Coast of Mississippi. Martof (1956, Amphibians and Reptiles of Georgia) lists this species as occupying the lower and middle Coastal Plain Provinces of the Atlantic and Gulf Coastal Plain Region. Four frogs of this species were collected from a brush pile at the edge of a pond behind the Officer's Club, Fort Benning, Feb. 10, 1943. All were males, with dorsal coloration varying from nearly uniform bright green to the typical pattern of *ornata* with stripes on a fawn ground color. Each had a dark stripe bordered with pale tan extending from shoulder to eye and a dark spot below eye, thus more closely resembling *P. streckeri* Wright and Wright than typical *ornata* in this feature. In all specimens a conspicuous vocal pouch with numerous longitudinal folds was noted, also mentioned by Wright and Wright as characteristic of *streckeri*. All of these frogs when first picked up exhibited a distinctive trait of body inflation and crossing the forelegs over the front of the head and eyes in a manner suggestive of bufonids, but a response never noted by me in Hylidae.

There are records of *ornata* for the Upper Coastal Plain of eastern and central Georgia, though until now apparently none for the western part of the state. Harper (1937, Amer. Midland Nat. 18 (2): 260) collected *ornata* in Burke Co.; Burt (1938, Trans. Kansas Acad. Sci. 41:344) also mentions a Burke Co. record; Brandt (1953, Herpetologica 9 (3): 143) Bleckley Co.; and Neill (1948, *ibid.*, 4(3): 108) listed it for Richmond Co., which is bisected by the Fall Line. Since all of these records are for eastern and central Georgia its occurrence in the Upper Coastal Plain of the extreme western part of the state is noteworthy.

Wright and Wright (*op. cit.*) record the Little Chorus Frog, *Limnaoedus ocularis* (Holbrook) from coastal North Carolina to Florida, the total range being co-extensive with that of *P. ornata*. Martof (1956, *loc. cit.*) indicated that *ocularis* was confined in Georgia to the middle and lower Coastal Plain Provinces. However, there are records for the upper Coastal Plain. Brandt (*loc. cit.*) Bleckley Co.; Neill (1947, Copeia 4: 272) from DeBruce, Richmond Co., a locality only 7 miles below the Fall Line. As with *ornata*, these records are for the eastern and central portion of the state. On March 14, 1943, several *ocularis* were collected and dozens observed along the grassy margin of a woodland pool at the Harmony Church area on the Fort Benning Military Reservation, Chattahoochee Co. This record extends the range of *L. ocularis* NW to the upper border of the upper Coastal Plain, five miles east of the Chattahoochee River, at the west edge of the state.

Martof (1956, *loc. cit.*) likewise indicated that the Squirrel Tree Frog, *Hyla squirella* (Sonnini and Latreille) was confined, in Georgia, to the middle and lower Coastal Plain. Upper Coastal Plain records, however, include: Jefferson Co. (Burt, *op. cit.:* 348, Harper, 1935, Amer. Midland Nat. 16 (3): 297): Bleckley Co. (Brandt, *op. cit.:* 144) and Richmond Co. (Neill, 1948 *ibid.:* 108; Neill, 1949 Copeia 1:78). In Richmond Co. the species reaches into the lower Piedmont (Neill, 1951, Amer. Midland Nat. 45 (1); 244). A single *squirella* was found in a

woodland pool near the highway at Warner Robins, Houston Co. approximately 16 mi. S. Macon, April, 1949. The short, rasping notes went almost undetected as the car was stopped at the edge of the pool. However, as it was heard again a short search revealed a single male on the branches of a small bush at the edge of the pool; with olivaceous-brown upper parts, yellowish venter and bright yellow rear surfaces of thighs. This record extends the range of *squirella* westward to Houston Co., adjoining Bleckley Co., where Brandt's specimens were taken.

The Fall Line apparently serves as a distinct barrier between the Piedmont fauna and that of the Coastal Plain Region, at least for anurans. However, the three Coastal Provinces of the Coastal Plain Region probably differ so little that the distributional patterns of amphibians may reflect local conditions of the habitat rather than major regions.

Grateful acknowledgement is here expressed to Wilford T. Neill of the Reptile Institute, Silver Springs, Florida, for advice and criticism and for calling to my attention some of the records herein reported from the literature.—*John D. Goodman, Department of Biology, University of Redlands, Redlands, California.*

THE SNAKE *THAMNOPHIS MARCIANUS* IN VERACRUZ, MEXICO —Although *Thamnophis m. marcianus* (Baird and Girard) is well known in northern Mexico, there are few records for areas south of northern Tamaulipas. Mittleman (1949, Bull. Chicago Acad. Sci., 8) and Shannon and Smith (1949, Trans. Kans. Acad. Sci., 52) record it from Villa Juárez, Tamps., and Taylor (1949, Univ. Kans. Sci. Bull., 33) from Ebano and Sabanito, eastern San Luis Potosí. On Nov. 27, 1957, the writer found a fresh DOR *marcianus* on Highway 110, five mi. w Tampico, Tamps., in the state of Veracruz. This is a range extension of approximately 75 miles southeast from Villa Juárez and provides the first known record from Veracruz. The specimen (Texas Univ. Natural History Collection 23056) is an adult male with part of tail missing; ventrals 152; scale rows 21-19-17; supralabials 8-8; infralabials 10-10; preoculars 1-1; postoculars 3-?; dorsal stripe anteriorly on vertebral row only, at midbody covering most of paravertebral rows; lateral stripes on row 3 anteriorly, 2-3 posteriorly.

This specimen agrees with Mittleman's diagnosis of *Thamnophis m. marcianus* and slightly lessens the gap geographically between it and the problematical *T. ruthveni* to the south. A specimen was collected alive along this same road in 1953 by the writer about ten miles east of the present locality, but was lost. Both snakes were found at night.

Of additional interest was the noticeable scarcity of amphibians and reptiles in this previously fruitful region. This was the only snake found in two days in the vicinities of Reventadero and Panuco. According to local reports reptiles have been scarce since the devastating hurricane and Panuco River flood of 1955.—*Theodore A. Klein, Jr., Box 7594 Univ. Sta., Austin, Texas.*

A New Tree Frog, Genus *Hyla*, From the Canal Zone

By M. J. FOUQUETTE, JR.

While stationed in the Canal Zone during 1955-1956, with the U. S. Air Force, I made a collection of amphibians and reptiles of the region. I concerned myself chiefly with the hylid frogs of the Pacific drainage of the Canal Zone. One of the species collected appears to be undescribed. I have chosen for this form the name

Hyla foliamorta sp. nov.

Holotype: Male, TNHC 23109. Collected the night of May 21, 1956, seven miles northwest of Miraflores Locks, Canal Zone, on the west bank of the Gaillard Cut. The frog was calling about six feet above the ground in cane grass growing along a roadside ditch adjacent to Empire Firing Range.

Paratypes: Four additional specimens, all males (TNHC 23110-23113) were collected in the same area during the remainder of 1956.

Diagnosis: A medium-sized *Hyla,* about 42 mm. snout to vent (males); head slightly longer than wide; snout long, rather flat, terminating in a point; nares area swollen. Vomerine teeth in two transverse rows located centrally between the large choanae. A distinct supratympanic fold. Fingers nearly free, only a trace of webbing. Toes about ¾ webbed. Heel extends beyond end of snout; heel-overlap about 6.5 to 7.5 mm. Skin smooth above, or with few small tubercles.

Brownish above with darker pattern of irregular marbling; a dark triangular marking between the eyes, bordered by a thin whitish line; sub-gular vocal sac strongly pigmented. Anterior surface of femur orange with at least one black blotch and two less distinct, irregular black spots, a small dark mark sometimes present in the groin; posterior surface orange with three moderately distinct irregular black blotches.

Description of the holotype: Head slightly longer than wide; snout long, low, broad, and rather flat; canthus rostralis not prominent; area around the nares swollen; loreal region slightly concave; end of snout distinctively pointed, extending 1.6 mm. beyond anterior border of nares; margin of upper jaw turned sharply under to meet lower jaw. Eye relatively small, length about ¾ distance between eye and nostril; width of eyelid slightly more than half the interorbital distance. Moderate tympanum, with a distinct supratympanic fold.

Vomerine teeth in two transverse rows between the large choanae, in a line opposite the approximate centers of choanae; space between choanae about twice length of a choana; tongue oval, about 2/3 as wide as long, slightly notched behind; openings to vocal sac prominent oblique slits lateral to tongue and opposite angle of mouth; a subgular vocal pouch. Arms short; only a trace of webbing between fingers; one elongate thenar and three palmar tubercles distinguishable, subarticular tubercles moderately distinct; width of discs little more than half diameter of tympanum, disc of first finger slightly smaller than the others. Legs rather long and slim; when laid alongside body, the tibiotarsal articulation extends beyond end of snout; when legs are folded at right angles to body heels overlap 7.5 mm. Toes about ¾ webbed—first toe nearly free; two-and-a-half phalanges of second toe free on inner side, outer side of second toe and

inner side of fifth toe webbed to disc; two phalanges of third toe free on inner side, one free on outer side; two phalanges of fourth toe free on either side; a distinct fringe continuing from the web to the discs on toes where webs do not reach discs. One inner and one outer metatarsal tubercle distinguishable, subarticular tubercles moderately distinct. Toe discs about the size of finger disc.

Color brownish above with a darker pattern of indistinct, mostly continuous markings; prominent dark triangular marking between eyes, bordered by a thin white line; ventral edge of upper jaw a distinctive dark brown. Scapular region with an oblique series of three small, elongate black spots; a black stripe on lateral edge of supratympanic fold; belly granular, immaculate except for some pigmentation along sides; subgular vocal pouch uniformly pigmented (brown); ventral surfaces of limbs

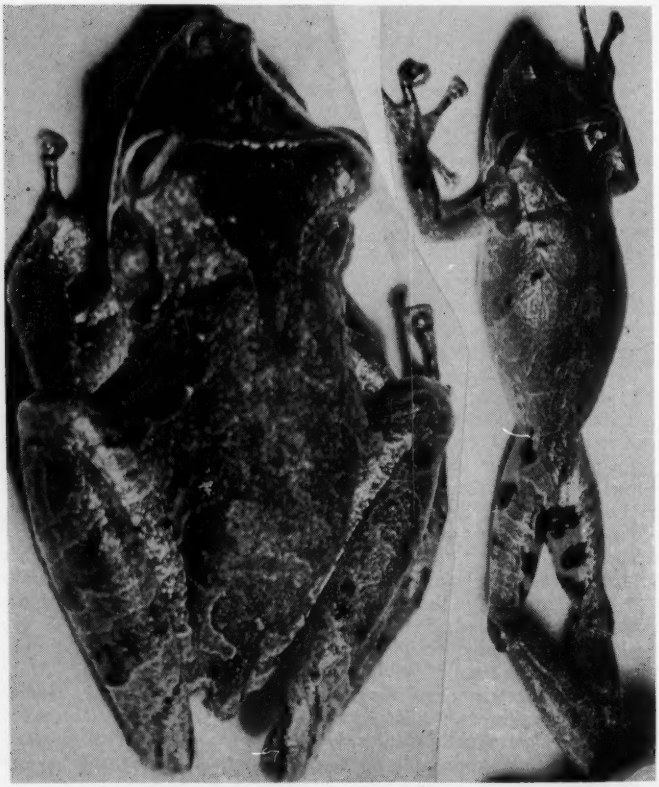


Fig. 1. Right, *Hyla foliamorta* sp. nov., holotype, TNHC, 23109, showing femoral pattern. Left, paratype, TNHC, 23110.

with considerable scattered pigment. Anterior surface of femur dull orange (in life), with two fairly distinct black blotches, a small dark brown mark in the groin; posterior surface of femur orange with three black blotches; indistinct banding on upper surfaces of limbs. The orange surfaces are not visible in the living frog when legs are folded in the normal resting position.

Measurements in mm.: Snout to vent, 41.3; head length, 15.5; head width, 14.1; eye length, 4.0; eye to nostril, 5.5; width of eyelid, 2.8; interorbital space, 4.5; tympanum, 2.6; arm, 25.0; leg, 71.0; tibia, 24.2.

Variation: An examination of the paratypes shows little variation from the holotype in most characters. The metacarpal tubercles are quite distinct in three specimens, in contrast to the rather indistinct ones of the holoype. There is noticeable variation in tuberculation. Some have very few and indistinct tubercles, as the holotype, whereas others may have a number of small moderately distinct tubercles scattered over the body, tending to be more noticeable in certain areas, especially the eyelids, interorbital space, anal region, scapular region, heel, and posterior edges of arm and tibia. The dark triangle between eyes, as well as the white line bordering it anteriorly, tends to be tuberculated. One shows a few additional black flecks in the scapular region.

The femoral blotches are more variable than other characters. The anterior surface has one fairly distinct black blotch and two other irregular black spots which vary. The small dark mark in the groin is rather distinct in two, faint in a third and absent in another. The posterior surface has three irregular blotches which are always moderately distinct but vary considerably in shape and size.

Variation in measurements of five specimens. Mean in parentheses. Snout to vent 38.9-42.5 (42.0), head length 14.3-15.9 (15.2), head width 13.5-14.8 (14.1), eye length 3.9-4.3 (4.1), eye to nostril 4.6-5.5 (5.1), width of eyelid 2.8-3.2 (3.0), interorbital space 3.8-4.7 (4.4), tympanum 2.5-2.7 (2.6), arm 22.5-26.5 (24.2), leg 68.5-73.5 (71.0), tibia 22.9-25.5 (24.2).

Breeding Call: A quiet, low-pitched, short trill, occasionally with a squeak at the end. It was difficult to locate individuals by following the call, because the call seemed as loud at 50 feet as at ten.

Recordings of the call were made with a Magnemite tape recorder. Sonagram analyses were made, but because of background noises a good picture cannot be presented at this time. Measurements taken from the sonagrams show that the call has a duration of about 0.28 seconds at about 25°C air temperature. The call repetition rate is about 15 times per minute, but these are not evenly spaced, the interval varying from two to nine seconds. The call is composed of 12 to 13 pulses. The dominant frequency, approximated by rough calculation of the fundamental, is about 2700 cps (cycles per second), although a dominant band extends from 2600 to 2900 cps. The most emphasized harmonics are the fundamental, about 144 cps, and others at about 3168, 2448, 792, and 1152, listed approximately in decreasing order of energy output. The entire call seems to fall within a frequency range of about 50 to 4500 cps.

Relationships: Hyla foliamorta is apparently closely related to *H. boulengeri* (Cope), which is common at the type locality of *foliamorta*,

and which ranges from Nicaragua to British Guiana. The following characters of *boulengeri* are useful in distinguishing it from *foliamorta:* Snout more rounded; heel extends only to between the eye and end of snout; th body is more noticeably tuberculate; the anterior and posterior surfaces of the thigh have a greenish cast, with more regular, pronounced black blotches; groin always with a prominent black spot; vocal sac has merely scattered streaks of pigment; the call is cat-like, non-pulsed, with a dominant frequency band about 2500-2900 cps and a strong harmonic band about 3100-3500 cps, duration about 0.39 seconds.

Other species which probably belong in the same group include *H. acuminata* Cope, which is recorded from northern Brazil, British Guiana, and Ecuador, and *H. proboscidia* Brongersma, described from Surinam. *H. acuminata* is distinguished from *foliamorta* by the following characters: Nares area not swollen, heel reaches only to anterior edge of orbit, vomerine teeth in rows opposite *posterior edge* of choanae. *H. proboscidia* is most easily distinguished from *foliamorta* by a considerable extension of the snout to form a "proboscis."

Remarks: All specimens collected at night by tracing the call. No females have been found. I have found *foliamorta* only in the immediate vicinity (within a mile) of the spot where the holotype was collected. Several more were heard that were not collected, due to the difficulty of following the call to its source. May, August, and September were the only months in which I heard them calling. The calling station is generally about four to seven feet above the ground in tall cane grasses or small palms. *H. boulengeri* is found in the same locality and generally calls from one to five feet up in grass or woody vegetation. I have never heard a *foliamorta* call except in this area, whereas *boulengeri* was heard rather commonly at numerous Canal Zone localities.

I wish to thank W. Frank Blair for reading the manuscript and making valuable suggestions.

DEPT. OF ZOOLOGY, UNIVERSITY OF TEXAS, AUSTIN, TEXAS

DICHOCEPHALY AND POLYEMBRYONY IN THE HOGNOSE SNAKE—On Oct. 2, 1957, three hognose snake eggs (*Heterodon p. platyrhinos*) were opened because of their failure to hatch. One egg contained two nearly fully-developed embryos, one two-headed, the other perfectly formed. The former was 80 mm. in length, the latter 75 mm. In the two-headed embryo the heads were joined at the sixth lower labial.

The egg was one of a clutch of nine laid July 14, 1957. The parent snake, completely black and 584 mm. in total length, was captured May 12, 1957, near Nashville, Indiana. Immediately after capture she was placed in a cage with a male of the common color phase.

When the eggs were laid, they were placed in a large jar with damp paper on the bottom and incubated at room temperature. Three eventually hatched on Sept. 26, 1957, 74 days after being laid; hatchlings 183, 188 and 190 mm. in length. All of the eggs which hatched or were opened contained spotted snakes.—*Jack Meyer, 1329 N. Drexel Ave., Indianapolis 1, Indiana.*